R E P O R T R E S U M E S

ED 018 660 VT 004 863

USING PROGRAMED INSTRUCTION IN OCCUPATIONAL EDUCATION.

BY- NORTON, ROBERT E.
NEW YORK STATE EDUCATION DEPT., ALBANY
STATE UNIV. OF N.Y., ITHACA

PUB DATE SEP 67

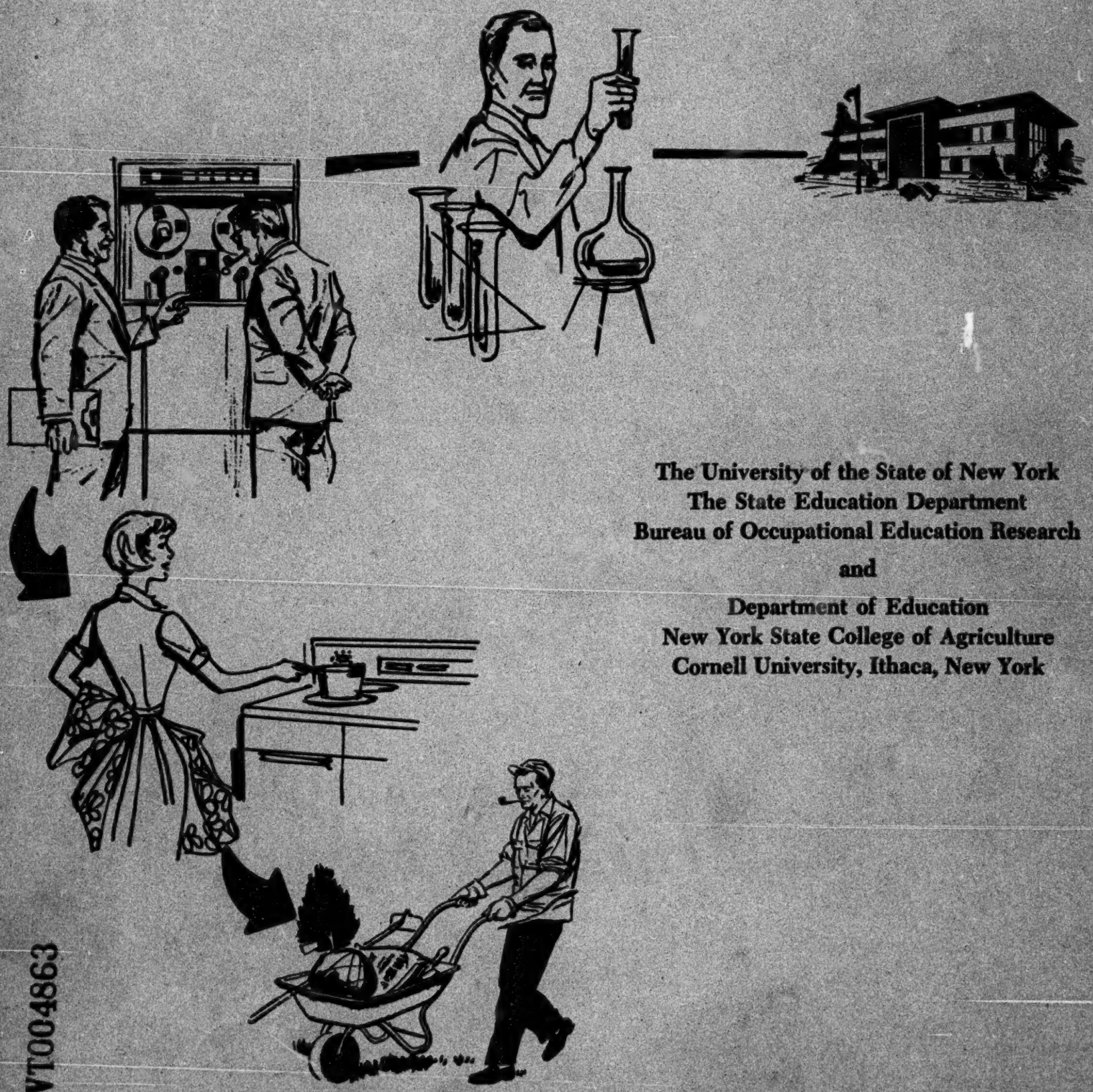
EDRS PRICE MF-$0.25 HC-$2.32 56P.

DESCRIPTORS- *PROGRAMED INSTRUCTION, *VOCATIONAL EDUCATION, *EDUCATIONAL PRINCIPLES, RESEARCH REVIEWS (PUBLICATIONS), *SELECTION, INFORMATION SOURCES, BIBLIOGRAPHIES, EVALUATION,

ALTHOUGH THIS REPORT ON THE STATUS OF PROGRAMED INSTRUCTION AND THE POTENTIAL IT HOLDS FOR SCHOOLS EMPHASIZES THE APPLICATIONS OF PROGRAMED INSTRUCTION TO OCCUPATIONAL EDUCATION, MUCH OF WHAT IS SAID IS ALSO APPLICABLE TO GENERAL EDUCATION. AN EXAMPLE OF PROGRAMED INSTRUCTION, AN OVERVIEW OF SUPPORTING PSYCHOLOGICAL PRINCIPLES, RESEARCH FINDINGS, SOME CONTROVERSIES, SOME ADVANTAGES, AND SOME LIMITATIONS OF PROGRAMED INSTRUCTION ARE PRESENTED. A DISCUSSION OF THE SELECTION AND USE OF PROGRAMED MATERIALS INCLUDES WHAT THE MATERIALS CAN TEACH, HOW THEY SHOULD BE USED, THE KINDS AVAILABLE, THE ECONOMICS OF USING THEM, AND RECOMMENDED SELECTION PROCEDURES. CASE STUDIES FROM SCHOOLS AND INDUSTRIES USING PROGRAMED INSTRUCTION SUCCESSFULLY IN OCCUPATIONAL EDUCATION ARE PRESENTED FOR BASIC INDUSTRIAL SKILLS, BUSINESS, ENGLISH, MEDICAL EDUCATION, HEALTH AND SAFETY, HOME ECONOMICS, INDUSTRIAL TRAINING, MEDICAL SALES, PERSONNEL PRACTICES, TRADE AND INDUSTRIAL, SELLING AND RETAILING, SPELLING, VOCATIONAL AGRICULTURE, AND 14 VOCATIONAL AREAS. ALTHOUGH THE SUCCESSFUL USE OF PROGRAMED INSTRUCTION HAS BEEN WIDESPREAD, ADMINISTRATORS AND TEACHERS SHOULD LEARN AS MUCH AS POSSIBLE ABOUT IT BEFORE ATTEMPTING TO USE IT, INVOLVE QUALIFIED TEACHERS, SELECT MATERIALS CAREFULLY, TRY IT ON A SMALL SCALE UNTIL IT IS PROVED SUCCESSFUL, FOLLOW GOOD MANAGEMENT PROCEDURES, AND INTEGRATE IT WITH OTHER METHODS OF INSTRUCTION. SOURCES OF PROGRAMED TEXT MATERIALS, RECOMMENDED REFERENCES, CRITERIA FOR ASSESSING PROGRAMED INSTRUCTIONAL MATERIALS, RECOMMENDATIONS FOR REPORTING THE EFFECTIVENESS OF THE MATERIALS, AND A BIBLIOGRAPHY ARE INCLUDED. (PS)

ED018660

USING PROGRAMED INSTRUCTION IN OCCUPATIONAL EDUCATION



The University of the State of New York
The State Education Department
Bureau of Occupational Education Research
and
Department of Education
New York State College of Agriculture
Cornell University, Ithaca, New York

VT004863

THE UNIVERSITY OF THE STATE OF NEW YORK

Regents of the University
With years when terms expire

1968	Edgar W. Couper, A.B., LL.D., L.H.D., Chancellor	Binghamton
1970	Everett J. Penny, B.C.S., D.C.S., Vice Chancellor	White Plains
1978	Alexander J. Allan, Jr., LL.D., Litt.D.	Troy
1973	Charles W. Millard, Jr., A.B., LL.D.	Buffalo
1972	Carl H. Pforzheimer, Jr., A.B., M.B.A., D.C.S.	Purchase
1975	Edward M. M. Warburg, B.S., L.H.D.	New York
1969	Joseph W. McGovern, A.B., LL.B., L.H.D., LL.D.	New York
1977	Joseph T. King, A.B., LL.B.	Queens
1974	Joseph C. Indelicato, M.D.	Brooklyn
1976	Mrs. Helen B. Power, A.B., Litt.D.	Rochester
1979	Francis W. McGinley, B.S., LL.B.	Glens Falls
1981	George D. Weinstein, LL.B.	Hempstead
1980	Max J. Rubin, LL.B., L.H.D.	New York
1971	Kenneth B. Clark, A.B., M.S., Ph.D.	Hastings on Hudson
1982	Stephen K. Bailey, A.B., B.A., M.A., Ph.D., LL.D.	Syracuse

President of the University and Commissioner of Education
James E. Allen, Jr.

Deputy Commissioner of Education
Ewald B. Nyquist

Associate Commissioner for Elementary, Secondary and Continuing Education
Walter Crewson

Associate Commissioner for Research and Evaluation
Lorne H. Woollatt

Assistant Commissioner for Research and Evaluation
William D. Firman

Director, Division of Research
Carl E. Wedekind

Chief, Bureau of Occupational Education Research
Louis A. Cohen

USING PROGRAMED INSTRUCTION IN OCCUPATIONAL EDUCATION

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Prepared by

Robert E. Norton

Research Associate
Department of Education
New York State College of Agriculture
Cornell University, Ithaca, New York

The University of the State of New York
The State Education Department
Bureau of Occupational Education Research
Albany, New York

September 1967

PREFACE

"Programed Instruction in Occupational Education" is the result of interest shown in the previous publication, "Using Programed Instructions With and Without Self-Instructional Practice to Teach Psychomotor Skills" by the same author.

The bulletin is intended as a guide to occupational teachers, supervisors, and administrators in planning, developing, and using various types of programed instruction as a guide in the learning process. It is desired that the information presented herein will result in units of instruction where students and teachers may benefit from such facilities useful in learning new skills to increase cognitive faculties in specific occupational areas.

The writer wishes to acknowledge the supervisory assistance of Professor Joe P. Bail, Chairman of the Agricultural Education Division at Cornell, who served as Project Director, and to Professor Frederick K. T. Tom, of the Agricultural Education Division at Cornell, who served as Project Director during the planning stages.

Similarly, gratitude is due Lyle Wicks, Instructional Materials Specialist, Division of Agricultural Education, for his many helpful suggestions and his assistance with the production of this publication.

Appreciation is expressed to Dr. Alan Robertson, formerly Chief of the Bureau of Occupational Education Research, who was responsible for initiating the project, and to Charles Meislin, an Associate in the Bureau, who served as project officer. Thanks are also due Dr. Louis Cohen, presently Chief of the Bureau, for his assistance with the final stages.

TABLE OF CONTENTS

I. INTRODUCTION 1
Purpose and Scope 1
Historical Sketch 1
Who Is Using Programed Instruction? 2
The Need and The Responsibility 2
Traditional Instruction versus an Instructional System 4

II. PROGRAMED INSTRUCTION - AN EXPLANATION AND OVERVIEW OF A NEW TECHNOLOGY OF TEACHING 5
What Is Programed Instruction? 5
Illustration 6
Underlying Educational and Psychological Concepts 6
Distinguishing Characteristics 8
Research Evidence 8
Controversies 11
Some Advantages 12
Some Limitations 13
Student Reactions 13

III. SELECTION AND USE OF PROGRAMED MATERIALS 15
What Can Programed Materials Teach? 15
How Should Programs Be Used? 15
What Kinds of Materials Are Available? 16
What Are the Economics of Using Programed Materials 16
What Selection Procedures Are Recommended? 17
What Administrative Changes Will Require Attention? 18
What Changes May Occur In The Teacher's Role? 18

IV. SOME SUCCESSFUL APPLICATIONS OF PROGRAMED INSTRUCTION 19
1. Basic Industrial Skills 19
2. Business 19
3. Elementary 19
4. English 19
5. General 19
6. Health-Medical Education 20
7. Health and Safety 20
8. Home Economics 20
9. Industrial Training 20
10. Industrial Training 20
11. Medical-Nursing-Sales 20
12. Personnel Practices 21
13. Trade and Industrial 21
14. Selling and Retailing 21
15. Selling and Retailing 21
16. Spelling 21
17. Vocational Agriculture 21
18. Vocational 22

TABLE OF CONTENTS (continued)

V. RECOMMENDATIONS AND CONCLUSIONS 23
Recommendations 23
Conclusions 24

APPENDIX A 25

APPENDIX B 32

APPENDIX C 35

APPENDIX D 49

CHAPTER I

INTRODUCTION

In an age where the acquisition of knowledge is the way of life for most people, programed instruction offers much: individualized rate of instruction, faster and more effective learning, immediate confirmation of student responses. Many students, especially those with low ability, experience for the first time a new feeling of success and confidence in their ability to learn. By means of carefully constructed sequences, the program takes each learner from what he knows to what we want him to know.

Today professional literature abounds with reports attesting to the fact that programed instruction has proved itself in industry, in the colleges, and in the armed forces. It is high time that programed instruction redeemed its promises in our schools. What can be done more effectively and more efficiently with this method should be done!

Purpose and Scope

The purpose of this publication is to present an up-to-date report on the status of programed instruction and the potential it holds for our schools. Most educators have not yet been convinced of the value and effectiveness of programed instruction, nor are they aware that it is a direct effort to implement modern learning theories and the results of current research by building them into a more effective, more scientific technology of teaching and learning.

The emphasis here is on the application of programed instruction to occupational education, but much of what is said is also applicable to general education.

An explanation of what programed instruction is, and an overview of supporting psychological principles, research findings, some controversies, some advantages, and some limitations of programed instruction are presented in Chapter 2. Chapter 3 gives practical and useful information on the selection and use of programed materials, and the fourth chapter cites numerous case studies taken from the experiences of schools and industry where programed instruction has been used in occupational education.

Three of the four appendices will be of special interest to teachers, administrators, and others who want to: (1) learn what materials are available commercially, and their sources (Appendix A), (2) read further about programed instruction (Appendix B), and (3) learn more about recommended procedures for selecting programed materials (Appendix C).

Historical Sketch

No single person can claim responsibility for the introduction of programed instruction. Instead, three persons - Sidney L. Pressey, B. F. Skinner, and Norman Crowder - are recognized as the outstanding contributors to its development. Teaching machines were first discussed by Dr. Pressey at an American Psychological Association meeting held in 1924. Pressey's approach is based on recognition of a correct response.

With the exception of research scientists and a few university educators, very little attention was paid these devices until the 1950's. A paper on conditioned learning by Harvard's Dr. Skinner, read before a conference of psychologists in 1954, is believed to have created a stir far beyond his immediate audience. Skinner, a well-known experimental psychologist, began to publish articles about the teaching machines he and his colleagues had developed. Much of his work was based on the principle of recall of information, a major feature of linear programing.

Because of serious teacher shortages and the need for new and improved methods of instruction, his writings were widely discussed and stimulated many people. One of the more notable of these was Norman Crowder who initiated and carried out extensive

work with the branching technique, known as intrinsic programing. During the last few years so many researchers have turned their attention to programed instruction that professional literature in education has been flooded with articles and research reports on it.

Who is Using Programed Instruction?

Unfortunately, there is no up-to-date information on the percentage of schools in the United States that is actually using programs published commercially or produced locally. Kenneth Komoski, director of the Center for Programed Instruction, Columbia University, stated in 1965 that a conservative estimate would probably not go beyond 10 per cent, but that an estimate of 20 per cent might not be far from the mark either. He also reported a great deal of international activity in programed instruction. Including work by educational ministries, other government agencies, universities, and industries, in 1965 between twenty and thirty countries were involved in researching, developing, and/or using programed instruction. Its proliferation in many directions is such that it must surely stand as one of the most rapidly developing and diffusing educational innovations of all time.

Far more startling is the use of programed instruction by industry. All types of organizations - from the industrial giants (Gulf, Ford, General Motors, DuPont, American Telephone and Telegraph, American Oil, U. S. Steel, IBM) down to local businesses (auto dealers, supermarkets, banks, tool and die shops, and department stores) - are using programed instruction wherever there is a training job to be done.

Illustrative of the extensive use of programed instruction by companies are two reports, one by the DuPont Company and the other by the Argyle Publishing Corporation. According to Dr. Arthur Santora, head of DuPont's Industrial Training Service, what DuPont did not intend to do, at the time they began working with programed instruction in 1959, was to get into the teaching business. But the same factor that got them started - a lack of commercially available courses in the desired skills - created a demand for their courses outside the company. Above and beyond their own internal demand of 55,000 course units in the last five years, there has been an outside demand for an equal number of course units in less than two years! Courses have been supplied to 1,200 other companies, many government and state agencies including the Bureau of Prisons and the Job Corps, hospitals, institutions, and vocational schools. Similarly, an Argyle sales brochure lists 132 major organizations including the Army, Navy, and Air Force and states that these are a few of the more than 9,000 companies now using Argyle programed instruction.

Education, however, is not keeping pace with industry. A 1966 National Education Association study of programed instruction in large school systems in the United States reports the grades and number of programs used in 126 school systems. A glance at Figure 1 provides an idea of where most programed instruction is presently being used in our elementary and secondary schools.

The largest percentage of use has been at the secondary level, with the ninth grade being the level at which the most extensive use occurred.

The Need and the Responsibility

Modern society is characterized by a high degree of technological innovation and sophistication. Joggled by a technology that changes faster than feminine fashions, industry is devoting ever more attention to training, retraining, and upgrading the abilities of its workers. Correspondingly, we might expect that through research and development education would also have turned to technology for assistance in meeting its increasingly important objectives, but actually education has not been characterized by technological innovation. Only recently have perceptive and forward-looking educators turned to technology as a means to improve education. Education has witnessed a technological lag rather than a technological revolution.

Are yesterday's methods and techniques capable of meeting today's needs? In the not too distant past, a man could learn a trade and look forward to practicing it the rest of his life without having to learn much of anything new. Today vocations change in many

Figure 1. Grades in which programed instruction was used in 126 large school systems

Grade	Number of Systems	Percent of Total Systems	Number of Programs	Percent of 378 Programs
1	2	3	4	5
K	2	1.6%	2	0.5%
1	20	15.9	23	6.1
2	14	11.1	17	4.5
3	9	7.1	12	3.2
4	28	22.2	41	10.8
5	37	29.4	56	14.8
6	38	30.2	58	15.3
7	45	35.7	70	18.5
8	50	39.7	77	20.4
9	67	53.2	121	32.0
10	57	45.2	96	25.4
11	48	38.1	74	19.6
12	43	34.1	76	20.1

important ways during each man's productive years. Every man must be prepared to learn and relearn a living throughout his life.

Educators have long idealized but never realized the educational goal of adapting instruction to the ability of the individual student. We are constantly pitching our classroom instruction to the level of the mythical average student while those of higher ability are bored, and those of lower ability, baffled. Can we allow this injustice to so many students to continue?

The findings of multicounty surveys in New York State indicate another definite need to expand and improve occupational education in New York State. Three of these findings, as presented in Education for Occupations, are as follows:

1. Statewide trends indicate a continuing need for development of higher skill and technological knowledge competencies among the work force.
2. Statements by employers and unions in the area studies certify that persons with vocational-technical skills needed in the work force are in short supply.
3. The multiple area studies confirm that many present school programs are inadequate in providing needed salable skills.

A representative of many industries, the National Association of Manufacturers, supports these findings in a case study which reports that many jobs continue to go begging because thousands of untrained or untrainable unemployed lack necessary basic educational skills.

What is our responsibility as educators? A statement printed in the NEA's January 1963 issue of Audiovisual Instruction relates our responsibility so well that it is repeated here.

> Education is a matter of individual human growth and development; therefore technological methodology must be introduced with care. Our primary concern is and must be the individual human personality - the nurturing of social and moral values, and, perhaps more to the point in our case, the development of rational thinking, of intellectual competence, of responsible action, and of productive ability.

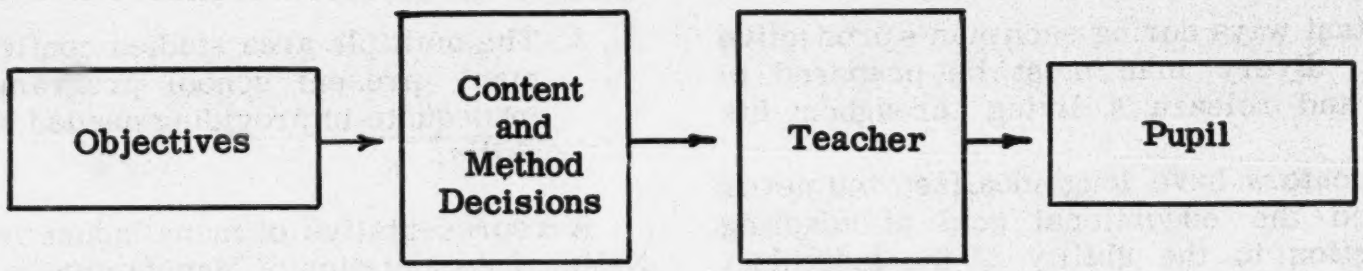
> Such development involves the transmitting (teaching) and mastering (learning) of a great deal of information and many complex skills.

The responsibility is clear and the need is evident. With full realization of the task to be accomplished, and the ever increasing shortage of qualified teachers, educators must turn to technology. Again to quote Audiovisual Instruction, "A technological leap forward is required in education."

Traditional Instruction versus an Instructional System

The very common direct teacher-pupil relationship, the basis of traditional education, is illustrated in Figure 2, taken from the NEA's January 1963 issue of Audiovisual Instruction.

Figure 2. Traditional Instruction



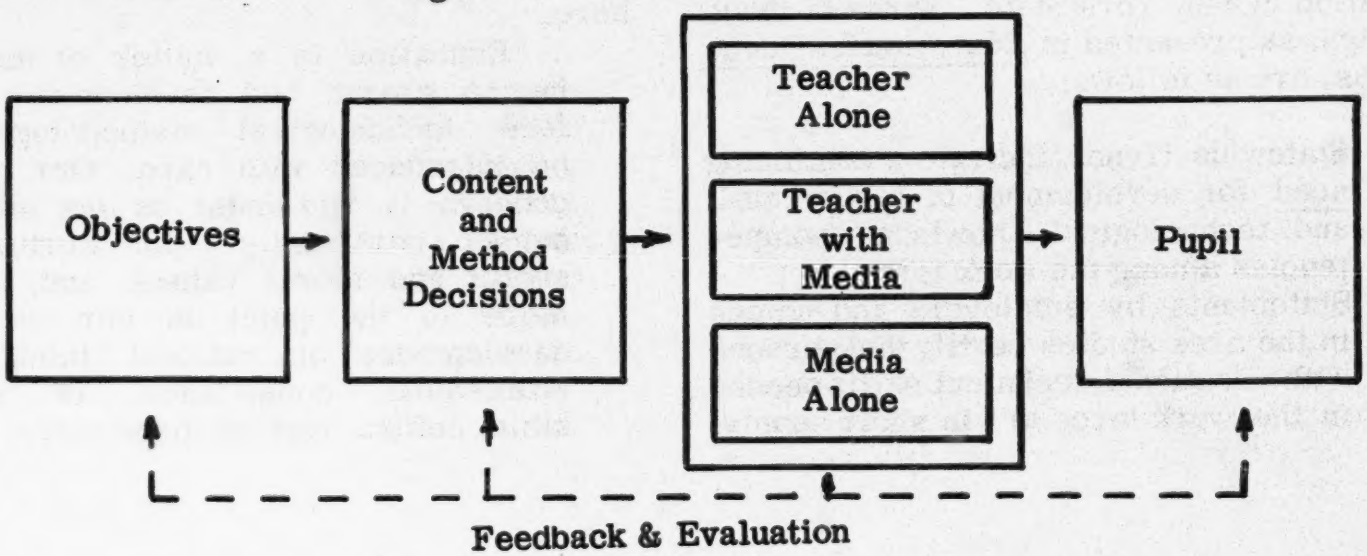
Although printed materials, chalk, and a few other devices came into play, there is little real technology involved in this instructional organization.

The new approach to a systems concept of instruction requires our earnest attention. This approach presents a scientifically developed arrangement of instructors, materials, and technological media for providing optimum learning with a minimum of routine personal involvement by the teacher. The result, as depicted in Figure 3, is a carefully planned system consisting of subject matter, procedures, and media coordinated in a program-unit design which is directed toward specific behavioral objectives.

The instructional system approach provides three alternate instructional routes and allows the teacher to select the most effective one for each learning situation. The teacher may present new material himself, select various media to help him with the presentation, or utilize media alone to make the presentation.

Another feature of the instruction system approach is that it provides for regular feedback and evaluation at all stages of the instructional process. Such feedback and evaluation, properly utilized, provides valuable information for revising objectives, altering curriculum content, and selecting the best methods.

Figure 3. Instructional System



The NEA article summarizes the function of educational media as twofold.

> The first function of technological media is to supplement the teacher through increasing his effectiveness in the classroom. Educational media are both tools for teaching and avenues for learning, and their function is to serve these two processes by enhancing clarity in communication, diversity in method, and forcefulness in appeal. Except for the teacher, these media will determine more than anything else the quality of our educational effort.
>
> The second function of media is one in which the media alone may present and, in a sense, teach certain content to pupils. Here, the teacher determines objectives, selects methods and content, and evaluates the final learning outcomes. The presentation of information, and even the direction of routine pupil activities, may be turned over to such new media as programed learning materials, television, or motion pictures. Function No. 2, then, is to enhance overall productivity through instructional media and systems which do not depend upon the teacher for routine execution of many instructional processes or for clerical-mechanical chores.

As the training director of a large New York City bank points out, "No one training method meets all requirements. A profit-oriented company or an educational system must provide the most effective training and education, using the most up-to-date and effective methods, and at the least cost consistent with good judgment."

CHAPTER II

PROGRAMED INSTRUCTION - AN EXPLANATION AND OVERVIEW OF A NEW TECHNOLOGY OF TEACHING

What is Programed Instruction

Programed instruction is one of several relatively new technological innovations in education. It is a process or technique for the design and development of self-instructional materials. A program of instruction is simply an instructional unit developed by means of this process. The process contains these essential steps: (1) establishment of specific behavorial objectives, (2) analysis of instructional content, (3) program production, (4) preliminary testing, (5) revision, (6) field testing, (7) final revision, and (8) validation.

It is a way of learning and a way of presenting materials to be learned. It is essentially self-instructional, meaning that basically the student is learning by himself and at his own pace with the help of a programed text or machine. Because it enables students to proceed independently, programed instruction is the first teaching technique that permits breaking the traditional classroom lock-step procedure.

Programed materials are based on a careful and detailed definition of learning objectives. To provide the learner maximum opportunity to attain these objectives, the subject-matter is broken into small, easily absorbed increments called "frames," which are carefully selected and sequenced to build on preceding units.

In each frame the learner must do something (active response) to show that he has grasped the information presented. The student can immediately check his answer against the correct one (confirmation). Thus the student knows whether he has grasped the information. If his response is correct, the program reinforces his learning through repetition; if incorrect, he can study the information again or ask his teacher where he went wrong. Having to act maintains his

attention, and knowing that he has acted correctly maintains his confidence.

Russell Pease, consultant for Dupont, in a talk that he gives on the subject, explains the value of this approach, "The increments of knowledge are readily understood and easily digestible. They are prepared so that a student's reply is almost always correct. The fact that the student is almost always correct encourages him. He enjoys his work. Learning becomes easy, pleasant and self-sustaining. The simplicity of this method is deceptive and the results are amazing." Educational psychologists have found that man learns better and faster when he is confronted with a minimum of errors. Most programed instruction is geared to this end.

In a very real sense, this technique narrows the communications gap between the students and the technical expert who wrote the course. It is almost like a tutorial relationship. Differences in age, education, job experiences, and learning speed tend to be neutralized - the learners emerge with more uniform levels of understanding because each sets his own pace and checks his own progress. By permitting flexibility heretofore impossible, programed instruction brings us closer than ever before to the goal of individualizing instruction.

Illustration

The best way to become familiar with the technique of programed instruction is to experience it yourself, if you have not already had the opportunity. With this thought in mind, the next page illustrates one type of programed learning.

Underlying Educational and Psychological Concepts

Programed instruction provides the first real penetration of psychological theory into the educational process. Here, in one of the few instances where the product of learning theory has found direct and practical application in the classroom, educational theory and a method of instruction converge.

Ernest R. Hilgard, professor of psychology and education at Stanford University, has described six established principles from the psychology of learning which support programed instruction.

1. Programed instruction recognizes individual differences by beginning where the learner is and by permitting him to proceed at his own pace. Individual differences in learning ability have long been observed in all areas of intellectual and motor activity. It is possible that programed learning may succeed in reducing large individual differences because of these features.

2. Programed instruction requires active participation on the part of the learner. Learning by doing is an old educational slogan, and is still a good one. Active participation by the learner leads to faster and more effective learning than does the more conventional learning situation.

3. Programed instruction provides for immediate knowledge of results. Whether it is because programed learning provides reinforcement, reward, or cognitive feedback, there is abundant evidence that immediate knowledge of results is important in learning. It favors learning the right thing while preventing the repetition and fixation of wrong answers.

4. Programed instruction reduces anxiety that so often is connected with the learning situation. The learner is not threatened by the task because he knows he can learn and is learning. This knowledge brings him satisfaction and increased confidence in his ability. The major principle involved is that learning motivated by success is more effective than learning motivated by failure or fear of failure.

5. Programed instruction provides spaced review in order to guarantee the high order of success that has become a standard requirement of good programs. If properly arranged, review permits a high degree of learning on the first run through a program.

6. Programed instruction emphasizes the organized nature of knowledge so often lacking with other methods of instruction. Good programs are written to provide for good continuity between the easier (earlier) concepts and the harder (later) ones. The process of programing requires examining the subject matter very carefully in order to find out what has to be known before something else can be learned, and eliminating side issues that do not lead to cumulative learning.

AN EXAMPLE OF LINEAR PROGRAMED INSTRUCTION

This page will demonstrate how programed learning works. Cover up the answers in the outside columns as you work through the "frames" of information. Check answer to each frame before going on to the next. (Reprinted, with minor changes, by permission of Office Equipment and Methods Magazine.)

1. Programed instruction learning of the linear type, as originated by Dr. B. F. Skinner of Harvard, breaks down subject matter into small chunks of information called frames. The unit of instruction in such a system is called a _____	
2. Each frame presents some new piece of information and calls for a response from the student. Therefore each frame calls for two actions. The student must read the _____ and make his _____	frame
3. This participation, or learning by doing, is the most efficient form of learning. So the student is assisted by his own_____	information or frame response
4. One way of getting a response from the student is to ask him to complete the blank space in a sentence. By filling in the _____space he is made to_____	participation
5. When a student has answered the question in a frame, he is given reinforcement. After answering the question, his learning is _____ by the correct answer.	blank respond
6. Periodically, a program will include a frame reviewing information that has gone before and calling for a series of responses to help fix the subject matter in the student's mind. Just like this: The unit of instruction in a program is called a _____. It presents _____ and calls for a _____ from the student. This may be done by filling in the _____ in a sentence. The student's learning is then_____ by the correct answer.	reinforced
7. The correct answer in a programed text can be conveniently placed alongside the next frame, as it is here. When the student has answered a question he turns to the _____ to check his answer.	frame information response blank space reinforced
8. A well-written program will draw the correct answer from a student most of the time. The student should answer almost all the questions_____	next frame
9. A program should do more than merely present information. It must teach the student. A program fails if it does not _____ and it must be revised.	correctly
10. Programed learning encourages each student to work at his own speed. He is not held back or rushed. He can move along steadily at _____	teach
11. Programs can be written for presentation in text form or for a teaching machine. A student can derive the same benefits from a _____ as he can from a_____	his own speed
12. Either way he is given reinforcement after his response by being told the correct answer. His _____ is obtained from the correct answer which he checks after making his_____	text teaching machine
13. Whichever method of presentation is adopted, it is the program not the presentation that is important. However slick the presentation, it will fail if the _____ is badly written.	reinforcement response
14. Programed learning is as good as the program and the program is as good as the programer. So the success or failure of a programed course depends on the skill of the _____	program
15. There are other forms and variations - but this small program should give you an idea of some of the basic principles.	programer

Distinguishing Characteristics

At this point you may ask: "What features distinguish programed materials from textbooks, workbooks, and other common teaching materials?" Persons well versed in programed instruction would describe it as a means of instruction with most, if not all, of the following characteristics:

1. Precise definition of objectives in terms of learner behavior, the achievement of which can be measured.
2. Presentation of carefully organized and sequenced information.
3. Arrangement of material in relatively small steps, each building on the preceding one, using steps that have been researched to provide almost errorless learning enroute.
4. Individualized instruction - the opportunity for each student to proceed at his own pace.
5. Structuring so as to elicit frequent responses, making the student an active participant throughout the learning experience.
6. Provision for immediate feedback, allowing for confirmation or correction of response.
7. Repeated testing or tryout with the target population and consequent revision to insure that learning outcomes have been achieved.
8. By reason of the above, an almost errorless, highly successful path to the desired learning.

These characteristics allow most users to specify a minimum acceptable standard for programed instruction of "90/90." This means that 90 per cent of the students must pass the final test with a grade of 90 or better. If they do not, there is something wrong with the program - not with the students.

These characteristics also allow a student of lower I.Q. usually to make as good a score as his classmates; it just takes him longer. This does not mean that "anybody can learn anything" but it is a big step in that direction.

Research Evidence

No method of instruction has ever come into use surrounded by so much research activity. Wilbur Schramm, director of the Institute for Communication Research at Stanford University, reviewed the research on programed instruction and summarized his findings in an annotated bibliography, "The Research on Programed Instruction." Many of the research conclusions presented here are drawn from his publication.

Do students learn from programed instruction? Schramm concludes "the research leaves us in no doubt of this." They do, indeed, learn from programs on machines and from programs in texts. Every kind of student that programs have been tried on has been able to learn - pre-school, elementary, secondary, college, adult, professional, skilled, unskilled, military, deaf, retarded, and prisoners. Using programs, these students have been able to learn math, science, history, spelling, electronics, business skills, reading skills, basic industrial skills, and many other subjects.

How well do students learn from programed instruction as compared to conventional kinds of instruction? It is difficult to generalize from comparative research because it is impossible to define a "normal classroom teaching situation." The outcome of such research often depends on what kind of teacher is being compared to what kind of program.

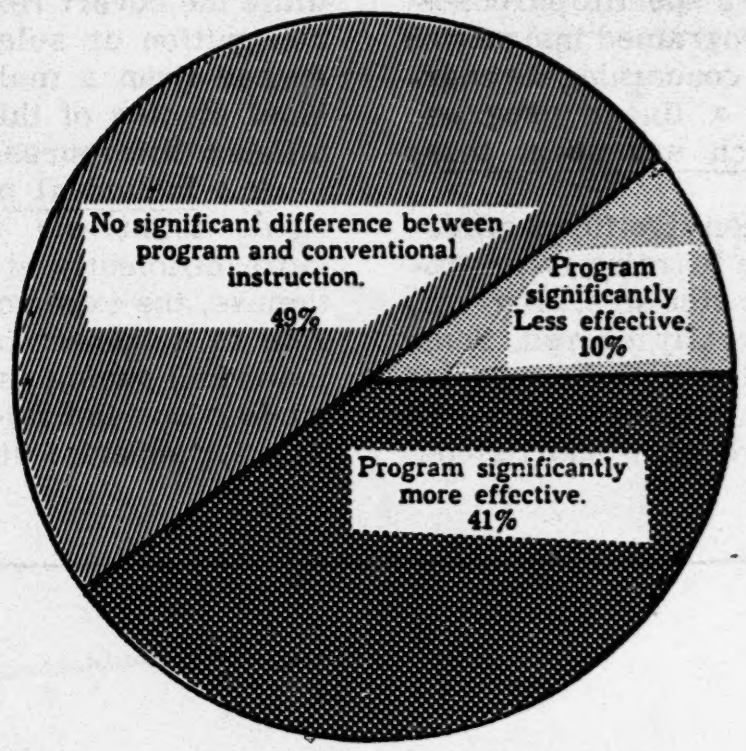
Keeping these limitations in mind, we turn to reporting the results of the evaluative studies made. An analysis by Hartley (1966) indicates that existing programs are overwhelmingly as effective as, or more effective, than traditional forms of instruction. (Figure 4)

Such results are even more astounding when one realizes that a majority of the commercially published programs have not been adequately tested. Komoski (1966) reported on the testing experience of 291 self-instructional programs currently marketed in the United States. Records show that 36 per cent were given no field testing, 32 per cent were tested only once, and 32 per cent were tested more than once.

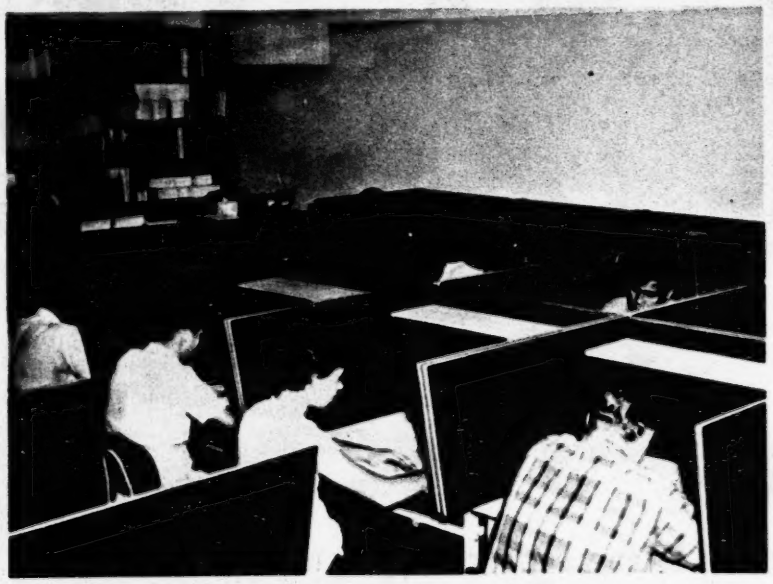
What is the effect of immediate knowledge of results? A majority of the studies on programed learning support the theory that immediate knowledge of results contributes to learning.

There are many areas in which the

Figure 4. Results of 112 Studies Comparing Programed and Conventional Instruction on General Effectiveness (Achievement and Efficiency)



research is not conclusive. Logic and caution are needed when making decisions on matters where only limited research is available. Following is a brief summary of some of these problem areas.



Some schools have constructed study carrels to help minimize distractions that may interfere with the study of programed materials. Photo courtesy of Albert Salerno, Mahoning Valley Vocational School.

What type of programing technique is best? By far the most common are the linear and branching types, each of which may employ numerous variations. These two and a less commonly known third type called "mathetics" are discussed in more detail later in this chapter. The great majority of studies on programed instruction has been done with linear programs. Where comparisons have been made, the evidence does not suggest any clear-cut superiority of the linear programing method over the branching, or vice versa. Rather, both approaches appear to have certain strengths and weaknesses depending on the individual student and the tasks to be learned.

Are machine presented programs more effective than programed texts? Some programs require a machine for their presentation, while some are available in two separate versions, one in book form and the other for use with a machine. In any case, it should be emphasized that the so-called teaching machines, in themselves, do not teach. The teaching is dependent on the programed materials which are presented through the machine. Research has not provided conclusive evidence of outright superiority of either machine or non-machine

presentation of printed materials. The choice of text or machine presentation probably will have to be made along pragmatic lines and in terms of the educator's specific purposes.

Much research on programed instruction has dealt with questions concerning the characteristic variables of a linear program. What does the research say about these characteristics?

(a.) Size of step. When significant differences have been found in learning from programs utilizing different step size, programs with short steps are generally favored. Some reports indicate, however, that superior students often become impatient and bored with long programs made up of short steps.

(b.) Overt versus covert response. The overt response technique requires the student to recall and write out his answer, while the covert response technique requires recognition or selection of the correct response from a multiple choice of answers. Most studies of this variable report no significant differences.

(c.) Individual pacing. Most of us would agree intuitively that students will learn more efficiently at their own pace. Nevertheless, the experimentors have not yet been able to demonstrate as much advantage for individual pacing as might be expected. Some studies have indicated that self-pacing worked best for superior students.

While adult trainees study their programed texts an instructor assists individual students whenever help is needed.

Photo courtesy of Dupont Company.

Controversies

Disagreements surround almost all new techniques. Programed instruction is no exception, and many controversies have arisen. Two of these issues merit further consideration here.

(a.) Books versus machines. Basically, a teaching machine is simply a device used to convey information using the technique of programed instruction. A common view, especially a few years ago, was that programed instruction required the purchase of expensive machines. As Komoski says, "It is regrettable that audio visualists, out of an honest desire to positively exploit any and all devices that might improve instruction, were the first group within education to actively promote programed instruction (or as they saw it, the teaching machine). The fact that this group, with its strong machine orientation, was closely associated with the new technology served to create the impression that the technology was necessarily machine-based. This inevitably helped fortify the apprehension of the rest of the educational community that the incipient technology contained more of what was threatening than it did of what was hopeful and promising."

Several machine manufacturers today publish their programs in two forms, as sheets to be used in their machines and as programed textbooks for use where a machine is not necessary or desirable. One supplier, Grolier, provides the following evaluation: "The primary utility of the machine is in the area of motivation and control. The machine is often effective in motivating the slow or reluctant learner. The control feature is most useful in unsupervised study situations and in educational research applications."

Certain problems must be confronted immediately by anyone desiring to buy teaching machines. A great variety of machines is available, and there is little standardization among them. In evaluating any make or model of teaching machine, you must also assess the type and quality of programs available for use in it. The mechanical dependability of many machines cannot be taken for granted. Potential purchasers should determine what maintenance problems have been encountered and the extent to which parts and service are locally available. Although programed textbooks may cost several dollars for a semester-length course, prices for teaching machines range from several dollars to several thousand dollars.

An instructor assists one student in the loading of her teaching machine while other students continue to study at their own pace.

Photo courtesy of Welch Scientific Company.

Although many kinds of "machines" - computers, television, tape recorders, and film projectors, among others - are being used to present programed materials, it must be emphasized that machines used in the automation of instruction are only vehicles for presenting the instructional program to the learner.

(b.) Types - Linear, Branching, and Mathetics. Throughout most of its short history, there has been general acknowledgment of two techniques of programing, the linear method and the branching or intrinsic method. Lately another technique, known as mathetics, has begun to gain acceptance as an efficient and tested method for imparting knowledge and skills. Although there are proponents for all three techniques who will argue that their particular approach is best, the research thus far available fails to indicate superiority of any one technique for all situations. No two tasks present the same teaching problem and no single teaching technique can solve every problem.

The majority of current programs are linear. Characteristics of linear programing are: (a) frames are very short, usually not more than two or three lines, (b) student must use recall to construct the response, (c) basic premise is that the learner should be successful at all times, (d) student proceeds through each step from beginning to end. Some linear programs incorporate an "express-stopping" technique which directs a student to skip ahead if he has demonstrated advanced knowledge.

The advocates of branch programing believe that the student can learn efficiently from errors as well as from responding correctly, and that he can absorb a relatively large quantity of information at one time. Characteristics of the branching technique are: (a) frames are large, often include entire paragraphs, (b) student is asked to recognize the correct response usually from a multi-choice type question, (c) assumption made that student learns from successes and mistakes, (d) student is individually handled by use of sub-sequences which branch off from the main line; a failure at a crucial point leads to alternate remedial materials. In most branching programs the program is constructed so the choice of a particular answer to a diagnostic question determines which frame will be presented next.

Mathetics is a relatively new programing technique being popularized by Teco Instruction (Ft. Lauderdale, Florida). Its format, when frames are used, resembles the branching technique. Individuation exercises are included, which may be skipped entirely by those already proficient but permit more instruction for those who need it. A major feature of this technique is the degree of task simulation used. Advocates hold that the greater the simulation, the greater the transfer. Therefore, many mathetical programs employ kits or simulators which include components quite similar to those which are used in the actual task. High costs of simulation have presented some economic problems. Printed matter in mathetics form is usually profuse with diagrams and pictures in varying stages of completion. According to its advocates, the active responses required of the student during the program are always, to the degree required, simulated performance of the task he is learning.

For example, if the task were inspecting steel drills, the kit accompanying the program would include a drill gauge and some actual drills ground in various ways. Incorporated into the program at appropriate places would be instructions which tell the student to pick up his drill gauge and check specific drills for lip clearance, lip angle, or whatever, depending on the point being made by the program.

There is little basis at present to favor any one of these general types over the other. Specific types of programs are likely to be useful for particular teaching problems. In some instances the most effective program may involve a combination of these different styles.

Some Advantages

Although many of the advantages of programed materials have already been mentioned, others have not been. For the convenience of the reader, those considered worthy of special note are summarized here.

1. They are self-paced, permit each learner to move through the sequence of responses at his own speed, and thus approach private tutoring.
2. They can free the teacher from the routine and drillmaster tasks of instruction and provide him with more time for creative and interpersonal activities with students.
3. They can successfully teach most kinds of information and certain skills.
4. They are efficient - unnecessary verbiage is eliminated and only information crucial in terms of the program's stated objectives remains.
5. They are based on sound theories of education and psychology.
6. The information presented is organized and sequenced for individual readiness.
7. Once oriented and motivated by the teacher, the student can learn alone with a good program.
8. A single teacher can monitor and help individual students who are working on a variety of subjects at the same time.
9. Learning tends to be of higher quality for all students because of the individual pacing and better control over what is presented and how it is presented.
10. The low error rate of most programed

materials is a great motivational tool in itself - especially for slower students who may be successful at learning for the first time.

Several other benefits of programed instruction have been realized by industrial giants like Dupont and the Proctor and Gamble Company. Most industrial training involves adults, who, for the most part, are seriously motivated by the desire to improve their rank and stature within the company. Whether these gains will be possible in occupational and other public educational situations still remains to be seen. With these precautions aired as a check against overenthusiasm the following industrial benefits are listed:

(a.) A 25-50 per cent reduction in training time.

(b.) 10-25 per cent more effective learning.

(c.) Savings of $30 to $60 per student per course, as compared to conventional training methods.

(d.) Uniform high quality instruction which is transmitted to job performance.

Some Limitations

Despite the fact that programed instruction has shown great potential, it is like most any other technological improvement in that it also has some limitations and disadvantages.

1. It cannot take the place of good schools or skilled teachers.
2. It cannot solve the problems of overcrowded classrooms.
3. It cannot succeed in classrooms where teacher attitudes toward it are hostile.
4. It cannot provide effective instruction unless the materials selected are properly prepared and tested.
5. Some students become bored after working with programs for some length of time.
6. Administrative problems of scheduling may arise when students using programed instruction and finishing at different times are scheduled for subsequent training as an intact group.
7. Teachers who will use programed instruction must be trained in the use and classroom management of such materials.
8. Selection of good programs that will fit in or complement the existent curriculum is not easy.
9. As with any technology, certain costs are involved - acquiring the program, training teachers to use it, and evaluating it.
10. The number of good programs available commercially is quite limited in some content areas. One survey indicated that approximately sixty per cent of the programs available were in the areas of mathematics, science, and English.

Student Reactions

Student evaluation of and comments about a new medium of instruction provide a good indication of how well they accept it and, in turn, an indication of how well they are likely to learn and like learning from it. The evaluation summary and student comments quoted below are reprinted through the courtesy of Mahoning Valley Vocational School, Vienna, Ohio, and its basic education supervisor, Albert A. Salerno. This school was created to provide saleable vocational skills for young men aged 16-21 who are either unemployed or underemployed. The Programed Learning Center at Mahoning was opened in August 1965. Using programed instruction in the Center atmosphere was another step toward "customized education" writes Mr. Salerno. Their philosophy of customized education is "an attempt to design a complete educational program for each of the students at the student's achievement level."

The student evaluation sheet used by a random sampling of 100 students at Mahoning at the end of one year is reproduced in Figure 5. The figures represent a summary of the students' responses. The evaluation sheet includes two items each on magazines and music which were included to sample student reaction to vocational magazines available in their library and to the playing of classical or semi-classical music three to four hours during the day.

Figure 5: STUDENT EVALUATION SHEET - PROGRAMED LEARNING CENTER

Please check as many boxes concerning your thoughts on the Programed Learning Center as you wish. We are very interested in your reactions to Programed Learning and to our Center. You may also want to add some of your own ideas in the space allotted at the bottom of the page. Naturally it isn't necessary for you to sign your name. Mr. Albert Salerno

"It helped me, and I learned a lot"	77	"Explained clearly"	59	"Don't like the music"	4
"Didn't help"	0	"Would like P.L. in other classes."	52	"Like the music"	88
"Liked it"	89	"Made me think"	61	"Am in P.L. too many hours"	3
"Waste of time"	0	"Know immediately why I'm right or wrong"	57	"Should be open at nite"	59
"Interesting"	84	"Liked working alone"	72	"No need to open at nite"	1
"Boring"	4	"Helped in my Vocational class"	64	"Like the magazines"	79
"Prefer to classroom	32	"Didn't really help in my Vocational class"	9	"Don't like the magazines"	2
"Good Review"	60	"Good study atmosphere"	69	"Am in P.LC. too few hours"	43
"Efficient"	58	"Poor place to do any studying"	1		
"Didn't like it"	0	"Not enough teacher help"	6		

This evaluation sheet was filled out by a random sampling of 100 students.

THIS SPACE IS FOR WRITING ANY ADDITIONAL COMMENTS THAT YOU MAY HAVE CONCERNING THE CENTER: (Note: This is a summary of the actual comments written by the 100 students.)

"This kind of program in high school would have helped the slow student gain confidence."
"Best equipped study center I have ever been exposed to."
"Quiet and convenient enough to do anything."
"Very helpful to me in Algebra."
"Teaches the student how to help himself."
"To the rest of the guys I've talked to P.L. has helped in their vocational areas."
"Need more books."
"Good chance to review."
"Get a greater variety of magazines."
"There is no one on my back, if I feel uninterested I can do something else."
"Can learn better at my own speed."
"First time I've had a self-tutor program and it is challenging."
"All trainees should take advantage of this. It teaches the fundamentals of a subject area."

CHAPTER III

SELECTION AND USE OF PROGRAMED MATERIALS

This chapter will cover only briefly certain topics related to the selection and use of programed materials. The brevity should not be regarded as an indication of the importance of the points covered. Selecting the best program available for your teaching objectives is highly important and not an easy task. And even the best program needs to be properly integrated into the existing curriculum and properly administered if its full potential is to be realized.

What Can Programed Materials Teach?

In theory, any subject that can be verbalized and/or illustrated in one way or another can be programed. Programing helps people learn simple skills such as accurate measurement with a micrometer, and complex skills such as calibration of a precision instrument. It is possible through a self-instructional program to teach a rather complex combination of cognitive and motor skills - the reading and interpretation of an electrocardiogram tracing, for example.

Programed instruction has been most successful to date in teaching cognitive material - facts, principles, concepts. These programs can be used from elementary to college levels for a great variety of subjects. One guide to available programs which classifies them by subject lists over 80 different subject matter areas.

Industry has made extensive use of programed materials in teaching basic industrial skills. A study in which this writer was involved raised serious question as to whether programed materials alone can satisfactorily teach a complex psychomotor skill such as regrinding a drill. The students had no difficulty in learning the necessary cognitive material from the program but had considerable difficulty performing the motions required for proper regrinding.

When teaching a skill, some programs call for the student to read each step in the book and then perform it with the actual equipment or simulated equipment. Similarly, the program may be supplemented with illustrations, photographs, samples, or other devices. These are usually called panels or exhibits and are designed as an integral part of the program. This procedure is basic to the mathetics programing technique and to this writer's knowledge is very effective. After such self-instruction, the learner usually performs the task in a real situation under the observation of a qualified instructor.

Visual techniques are sometimes used to present vocational subject matter.
Photo courtesy of Albert Salerno, Mahoning Valley Vocational School.

How Should Programs Be Used?

Much remains to be learned about how a program can best be used in a course. One fact is certain - programs can be used in a variety of ways. They may be employed as the main source from which students are expected to learn facts, principles, or certain skills. Some feel there is a place for programs which will even teach a subject without an instructor. These might be appropriate for adults or for remedial courses designed to provide review for students entering college without sufficient preparation.

Other programs should be used to teach parts of courses, to introduce other instruction, or to provide enrichment material for students with special interests and abilities. In most schools, programs should be used in conjunction with other media as one of the means of teaching a course.

The NEA sound filmstrip, "Selection and Use of Programed Materials," summarizes the seven most common uses of programs as follows:

1. Basic instruction.
2. Incidental instruction.
3. Correlated instruction.
4. Remedial instruction.
5. Enrichment.
6. Substitute instruction.
7. Research.

What Kinds of Materials Are Available?

There has recently been a dramatic increase in the number of commercially available programed texts in a variety of subject matter areas. More will be said later, but mere availability is no guarantee of quality.

The most comprehensive list of programed courses available in this country has been produced by Carl Hendershot of Delta College, Bay City, Michigan. His publication, "Programmed Learning: A Bibliography of Programs and Presentation Devices," includes programs covering over 80 subject matter areas. The current revision (1967) lists the addresses of 150 program publishers and includes over 2,500 programs with brief descriptive information about each. Pertinent data given include the title, author, approximate length, intended student population, and price. No attempt has been made to evaluate the programs, but the compiler has pointed out prerequisite knowledge and other facts to help determine the program's possibilities for various instructional situations.

In Appendix A this writer has compiled lists of publishers of programs relevant to occupational education. The listing does not include prices, titles, or other descriptive information. Because new programed materials are appearing rapidly, all available programs may not be listed here. To stay well informed, you must subscribe to one or more of the general listings and/or request that individual publishers keep you on their mailing list.

What can be done if there are no high quality programs available in the desired subject area? The answer of course is to consider the possibility of writing your own. Remember, however, that preparing a programed instruction course is a demanding and exacting task - and usually a long one. The typical program author needs about six months to complete his research, writing, testing, revisions, editing, and production before the course is ready to be used. Short courses in how to program (offered by the University of Rochester and the University of Michigan) are highly recommended to anyone planning to do much programing.

The Denver, Colorado, school system has discovered certain advantages to encouraging some local production even though it depends on commercial materials for most needs. Locally produced programs may be more tailored to the needs of the particular school. And more importantly, they conclude, the principles of programing will tend to spill over and improve all teaching and all teaching materials.

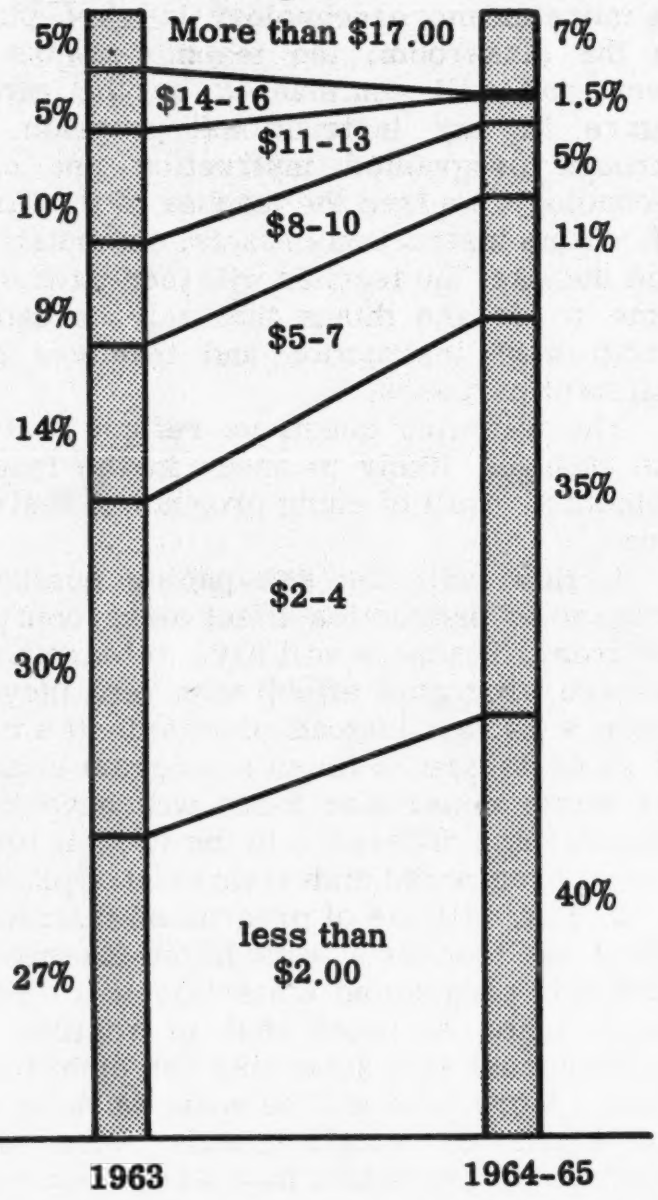
What Are the Economics of Using Programed Materials?

Figure 6, which shows the trend in costs of programed texts, was prepared by the editors of Programed Instruction. While in 1963 slightly more than half of all programs sold for school use were priced at $4.00 or less, during 1964-65, 73 per cent of the programs produced were sold in this cost range. This trend occurred in spite of the fact that during the same period the average length of programs increased. Most publishers are attempting to make programed materials more economically competitive with other kinds of instructional materials. One way this can be accomplished is by producing reusable programs which require only the purchase or duplication, if permitted, of student answer sheets in succeeding years.

Teaching machines vary in cost from several dollars to several thousand dollars. Their costs have remained substantially the same probably because the high cost of some hardware and its fragility in student hands have resulted in a low sales volume. The

cost of programs designed for machine use has declined somewhat.

Figure 6. Programed Text Costs



Local or in-house production of tested high quality materials can be quite costly. Dupont estimates that it costs them approximately $3,000 to $4,000 per course hour for materials developed by company personnel. Most school teachers and administrators should carefully scrutinize commercially available programs before attempting to write their own.

The cost of industrial training by programed instruction, as reported by the Resources Development Corporation, is surprisingly low - less than $1.00 per hour of training for materials developed for industry-wide audiences. This, they report, compares very favorably with the cost of assembled training - instructor time, classroom facilities, training materials, and other overhead which starts at $11.00 per hour per man. Needless to say, public educators have not been able to realize similar economic benefits.

What Selection Procedures are Recommended?

Program evaluation is difficult. The benefits of programed instruction can be realized only if users have adequate information with which to evaluate self-instructional materials. Since many programs of varying quality (from poor to excellent) are available, careful selection is crucial. Some practical suggestions are presented here which will assist teachers and administrators charged with this responsibility. Because of space limitations, this discussion is necessarily brief; however, evaluation is of such importance that in Appendix C a classic statement on "Criteria for Assessing Programed Instructional Materials" is reproduced. This statement was prepared by a joint committee made up of representatives from several professional organizations concerned about providing direction to the production, dissemination, and utilization of programed materials.

The following steps are recommended as a procedure for evaluating a program.

1. Read the program carefully and thoroughly.

2. Compare the compatibility of its content with your instructional objectives.

3. Examine the adequacy of programing. The frames should present a careful, logical progression toward mastery of the subject matter. Students should be required to respond to critical aspects of each item or to perform the operation that step was meant to teach. The format should be an attractive one, appropriate to the subject matter and to your students. The reading level must be suitable.

4. Examine the field test and other validation data available. They should provide information on the program's effectiveness and efficiency.

5. Experiment with the program on a small group of students before adopting it on a wide scale.

What Administrative Changes Will Require Attention?

Effective use of programed instruction in any school system will depend upon administrative assistance, guidance, and support. Charged with the responsibility for guiding and unifying the efforts of the school system toward specific objectives, the administrator will want to consider the following questions relating to the use of programed instruction.

1. What orientation or training should be provided teachers before they use programs? Consideration should be given to holding in-service workshops for the faculty to acquaint them with the medium.

2. What orientation should be provided students and parents? Some publicity about the nature of programed instruction and reasons for introducing it is recommended.

3. What effects will the use of programed materials have on curriculum and scheduling? Certain curriculum changes may be desirable because of the greater opportunity for individualized instruction. Individual pacing may also require more flexible scheduling; students starting a program at the same time will not all finish at the same time.

4. What will be the financial needs? Probably an overall financial plan should be established, one which looks ahead to continued use of programed materials. Consider the costs of acquiring programs, training teachers to use them, and evaluating them. Financial assistance is available from the federal government under several education acts.

5. What logistical problems - space, building design, etc. - will need attention? Some schools are establishing special programed learning libraries where students can come, check out a programed text, and study during their free time. Most use programs in their regular classrooms. Others have built carrels for individual study.

6. What changes may be necessary in reporting pupil achievement? In most cases, regular course credits probably will be granted upon passing course exams, but additional credit may be granted to students who complete extra programed course material.

What Changes May Occur in the Teacher's Role?

Though his role may change considerably as more and more technology finds acceptance in the classroom, the teacher always has been and will continue to be the central figure in any instructional program. If, through programed instruction and other technology, we free the teacher of the burden of routine instruction in facts, computations, and the like, the teacher will then have more time to do the things that only he can do. Programed instruction and teachers have different purposes.

The following questions reflect some of the changes likely to occur in the teacher role as a result of using programed instruction.

1. How will the self-pacing quality of programed instruction affect classroom procedures? Teachers will have to learn how to manage programs effectively, lest they become a burden instead of an aid. If a class of students are to finish a program at about the same time, then there will have to be considerable difference in the starting times. Use of programed materials must be planned.

2. How will use of programed instruction affect the teacher's work in the classroom? Although programed materials will relieve the teacher of much that is routine, the teacher must still supervise use of the materials. More time will be spent working with individuals or small groups when using programed instruction than was possible with conventional instruction.

3. How can the teacher reinforce the program? By being thoroughly familiar with its content, by using good management procedures, and by displaying a positive attitude toward its use, a teacher can contribute greatly to successful use of a program. As with any type of instruction, the teacher should develop an enthusiastic climate for learning.

4. How will the teacher evaluate student progress? The method of grading and testing should be carefully explained to students. They must understand they are not being tested while working on the program itself. Regular testing and reporting procedures are easily adapted for use with programed instruction.

5. What should be the teacher's responsibility with regard to programed instruction? Certainly the teacher should strive to become well informed about programed instruction and its uses. In most schools, teachers using programed materials will have a voice in their selection. Thus, the teacher must learn to distinguish between a poor program and a good one. He should want to attend in-service workshops to learn about program development, to get experience in writing frames, and to discuss their use in the classroom.

CHAPTER IV

SOME SUCCESSFUL APPLICATIONS OF PROGRAMED INSTRUCTION

This chapter reports on several case studies where programed instruction has been successfully used. Case histories involving as many occupational education areas as possible have been included, although cases are not specifically identified as to vocational field. The histories include situations involving elementary and secondary education, industrial training, general and vocational subjects.

1. Subject Area: Basic Industrial Skills

Program(s): Varied
Results: Dupont's experience with programed instruction courses in 106 skills since 1959 shows that this new technique trains operators 25-50 per cent faster and 10-25 per cent more effectively. In the new technique of programed instruction, they found a training tool that costs $30-$60 less per student per course compared to conventional training methods.
Source: Dr. Arthur Santora, Head, Industrial Training Service, Dupont Company, Wilmington, Delaware.

2. Subject Area: Business

Program(s): Several texts using the mathetics design (including simulated practice exercises) to train bank tellers.
Results: Retention immediately improved and the amount of verbal instruction was reduced from 48 hours to 6 hours; resulting in a shortening of the average training period from five weeks to as little as three weeks.
Source: Gordon Rhodes, Director of Training, First National City Bank, New York, New York.

3. Subject Area: Elementary

Program(s): Varied
Results: "Experimentation conducted thus far supports the expectation that good programs, carefully developed, can significantly improve the quality and economy of instruction. Whether any particular program will do so is subject to question until established by adequate tests of that program."
Source: Programed Instruction Project - Annual Report, 1965-66, Board of Education of the City of New York, New York.

4. Subject Area: English

Program(s): Grammar from commercial source, one year length.
Results: Respondent reported, "Program used with accelerated classes. This method of teaching English grammar was found to be as good or better than the conventional method for these classes. The method consumed less instructional time."
Source: Warren, Ohio Public School system as quoted in NEA's Educational Research Service Circular #7, 1966.

5. Subject Area: General

Program(s): Varied
Results: Dr. Carl Hendershot, consultant to business, industry, colleges, and schools, has experienced extensive association with the selection and use of programed instruction. At Delta College, programs have been

used under his direction since 1961 as basic texts, supplementary texts, and for both adult and student self-instruction. In all of these applications, programed texts selected to meet the requirements of instruction and the needs of the student have produced highly desirable results.
Source: Coordinator of Improvement, Delta College, University Center, Michigan.

6. Subject Area: Health-Medical Education

Program(s): A linear program on "Allergy and Hypersensitivity"
Results: Announced in 1963, the demand for this publication by individuals, medical schools, local medical societies, specialty groups, and others has been so extensive that over 200,000 copies have been distributed. More than two-thirds of the medical colleges are using the program as an instructional segment of their curricula.
Source: Dr. Jerome Lysaught, College of Education, University of Rochester, Rochester, New York.

7. Subject Area: Health and Safety

Program(s): A two-hour program on how to "positively reinforce" employees for proper lifting.
Results: Program was administered to supermarket supervisors in two widely separated parts of the country. Before the training, 39 back injuries were reported in a six-month period; only three were reported in the six months following training. (Average cost of each back injury estimated at $4,050.)
Source: Brochure prepared by Center for Programmed Learning for Business, The University of Michigan, Ann Arbor, Michigan.

8. Subject Area: Home Economics

Program(s): Nutrition, from commercial source, one semester length.
Results: Respondent reported, "We received reasonably good results from this program in meeting a specific need. Programs centering on a specific topic seem more successful than total programs."
Source: Gary, Indiana, Public School system, as quoted in NEA's Educational Research Service Circular #7, 1966.

9. Subject Area: Industrial Training

Program(s): Varied
Results: Dr. Garland S. Wollard, director of education for the Federal Bureau of Prisons, reports that the experiences gained at the Petersburg Reformatory have been so encouraging that he plans to introduce programed instruction to the other five federal reformatories as well as to two federal penitentiaries. One of the by-products of the Petersburg experiment was that inmates felt they could do something to improve themselves. This replaced a feeling that they were being "used" by the institution.
Source: Article in New York Times by Gerd Wilcke, spring 1967.

10. Subject Area: Industrial Training

Program(s): Varied
Results: The Boeing Company first offered programed instruction on a voluntary trial basis in January 1966. Results have been such that they expect to enroll 10,000 students in 50 courses in 1967. Employees have to pay for their own text, study the course off-hours at the time and place of their own choosing, and at their own pace. Some overall conclusions have already been made: (a) A large majority of their employees likes the programed instruction method. They want to learn whenever and wherever they choose, at their own speed, away from the classroom. (b) Future course enrollment and interest in programed instruction and adult education will continue to accelerate.
Source: Article in "Training in Business and Industry" by Paul Watson, Programed Instruction Coordinator, The Boeing Company, Seattle, Washington.

11. Subject Area: Medical-Nursing-Sales

Program(s): Two programs, each approximately six hours long, one on a complex disease and the other on a drug to combat it.
Results: New company salesmen were reluctant to discuss this drug with physicians until they had been on the job six to nine months. After completing the program, new salesmen now approach the physician on the

particular drug within the first month they are on the job, resulting in new sales personnel being productive six months sooner.
Source: Brochure prepared by Center for Programmed Learning for Business, The University of Michigan, Ann Arbor, Michigan.

12. Subject Area: Personnel Practices

Program(s): One and a half hour program developed to train supervisors in the use of a new complex computer form for personnel records.
Results: Program was distributed to 5,000 automobile manufacturing employees across the country before switching to new system. New system is functioning with no problems, even though errors had to be non-existent in order to insure its success.
Source: Brochure prepared by Center for Programmed Learning for Business, The University of Michigan, Ann Arbor, Michigan.

13. Subject Area: Trade and Industrial

Program(s): Machine Shop - programed materials include slides, tapes, and printed materials - all teacher produced.
Results: Respondent reported, "Has truly individualized instruction and made instructor available for greater personal supervision. Also makes last hour class as effective as first."
Source: Independence, Missouri, Public School system, as quoted in NEA's Educational Research Service Circular #7, 1966.

14. Subject Area: Selling and Retailing

Program(s): "Making Courtesy Work for You" and "Making Suggestions to Increase Sales."
Results: The actual sales increases recorded have convinced Allied Stores of the programs' effectiveness. Tests showed an increase in sales dollars per hour over the control group of 25 per cent by the programed group and 8.3 per cent by the classroom group. As a result of these tests, store personnel and training directors have been advised to use the programed manuals as the basic tools of retail sales training.
Source: Article in "Department Store Economist," written by Frederick Finigan, Personnel Director of Allied Stores, April 1965.

15. Subject Area: Selling and Retailing

Program(s): Thirteen separate self-study units on retail food store operations.
Results: A research study was conducted by Western Michigan University to determine the effectiveness of the program. Tests were administered to a typical group of store employees before and after they studied the units. A substantial and significant improvement was found in the knowledge level of the group. The employees found the materials interesting, they found the learning easy, and they felt they had significantly increased their understanding of store operations.
Source: Announcement brochure from Sales Training Department, The Quaker Oats Company, Merchandise Mart Plaza, Chicago, Illinois 60654.

16. Subject Area: Spelling

Program(s): TMI-Grolier Spelling
Results: A controlled experiment was conducted using two classes of 30 students each selected from a cross-section of ability levels. One sixth grade group was given the program and the other was taught conventionally with textbooks. Students who used the program scored higher gains after eight weeks of study than the conventionally-taught class after twelve weeks of study. Programed learning saved time for above average students and eliminated the problem of loss of instruction resulting from illness as well as the problem of how to work with a new student in the class.
Source: Research Department, Educational Divisions, Grolier Inc., New York.

17. Subject Area: Vocational Agriculture

Program(s): Parliamentary Procedure, five to seven hours.
Results: A research study conducted at Cornell University studied the relative effectiveness of supplementing programed instruction with blocked versus spaced review. The program was administered to 279 first year vocational agriculture students in New York State. Conclusions drawn were that neither spaced nor blocked review resulted in sig-

nificantly better performance than was obtained from the program alone.
Source: Final Report, "The Relative Effectiveness of Supplementing Programed Instruction with Blocked Versus Spaced Review," by James A. Scanlon, Cornell University, May 1967.

13. Subject Area: Vocational

Program(s): Varied - 14 vocational areas
Results: Programed courses at Mahoning Valley Vocational School offered students a chance to pursue vocationally oriented subjects at their own pace, with a minimum of trouble or error. The low error rates and questions-response-check format of programed instruction was a great motivational tool in itself. This type of learning situation actually built confidence and gave direction to students. Changes in skill behavior could definitely be observed in their vocational classes. An increase in the knowledge and skills experienced by our students was most evident on our post-test results.

Three conclusions drawn by the coordinator of the Mahoning Programed Learning Center at the end of the first year were as

Some vocational schools and many companies are establishing programed learning centers or libraries. Students may be allowed to select materials according to their interests or be assigned specific materials. Photo courtesy of Dupont Company.

follows:

1. That programed texts were successful in vocational training.

2. That students who are properly oriented and counseled can work for extended periods of time on programed courses.

3. That both basic education and vocational skills can be developed or improved upon through programed instruction.

According to the basic education supervisor, experimentation in this new educational device has brought many benefits to Mahoning Valley and the vocational movement in Ohio. Vocational trainees are now better prepared for jobs as a result of this success, joint vocational schools in Ohio are now incorporating programed learning centers in building plans, and Manpower Development and Training Act city programs are incorporating programed learning centers in Ohio.

Source: Albert Salerno, Mahoning Valley Vocational School, P. O. Box 278, Vienna, Ohio 44473.

It is impossible to present a complete picture of current developments and applications of programed instruction. The interested reader is referred to the following two reports which contain additional case studies.

"Programed Instruction in Large School Systems"
Educational Research Service Circular No. 7, September, 1966.
National Education Association, Washington, D.C.
(Available for $1.75 each from Educational Research Service, 1201 Sixteenth Street, Washington, D. C.)

Four Case Studies of Programed Instruction
Fund for the Advancement of Education
477 Madison Avenue, New York, New York 10022
(Dated June 1964, available free.)

CHAPTER V

RECOMMENDATIONS AND CONCLUSIONS

Recommendations

Programed instruction can be a success or a failure in any school system. Although the potential is great, programing is not a cure-all. Teachers and administrators must be careful in the use of programed instructional materials. The following recommendations can help in effectively developing the potentialities of programed instruction.

1. Learn as much as possible about programed instruction before you attempt to use it. See Appendix B for suggested readings.

2. Seek the opinions of persons using programed instruction in your area, preferably those teaching your subject. If this is not possible, write to teachers in other locations.

3. Involve qualified teachers who are willing to learn about and try something new.

4. Inform faculty members, students, parents, and others in the community about programed instruction and seek their help in evaluating it.

5. Select materials very carefully. Good programs are challenging, not boring or insulting. The potential user of programed instruction should learn to discriminate between an actual program and conventional instruction presented in a programed format. Remember, evidence based on student performance is needed to demonstrate that a program actually teaches.

6. Try programed instruction on a small scale. Consider the project an experiment until it is proved successful in your school. Wide scale adoption can follow.

7. Follow good management procedures. The programed instruction effort must be effectively managed. Without direction or purpose, its effects are unpredictable - sometimes it will work well, at other times

the effect may be unclear, and sometimes it will fail miserably.

8. Integrate programed instruction with other methods of instruction. Programed materials should be viewed as part of a vast array of instructional materials available to teachers and students. The full potential of programed instruction cannot be realized by its use alone; instead, the teacher must use it and other methods to supplement his efforts in the best possible way.

Conclusions

Programed instruction shows outstanding promise of making a definite contribution to education. An uncritical acceptance of programed materials or a premature or uninformed rejection of them would be most unfortunate. All indications are that with imagination, resourcefulness, and adequate preparation in the use of this medium, all concerned will benefit. As teachers gain experience with the technique, the benefits and learning principles involved in programed instruction also may be incorporated into other media of instruction.

Programed instruction has been called "infinite consideration for the learner." It represents the first real penetration of psychological theory into the educational process. Research conducted thus far supports the contention that good programs, carefully developed and properly administered, can significantly improve the quality and economy of instruction.

The advantages of programed instruction outweigh its disadvantages. Its limitations must be recognized; it is not a panacea for all of education's ills, nor will it revolutionize education overnight. However, its main advantages - individualized rate of instruction, shortened learning time, more effective learning, and ability to relieve teacher fatigue - cannot be denied or ignored by educators.

Programed materials offer a great amount of versatility in occupational education. They may be used as developmental, remedial, or accelerated tools depending upon the students and their needs. Adults as well can profit a great deal from self-instructional materials. The logical structure and built-in success factor of programed materials offer students a chance to increase knowledge and skills at the same time motivation to learn is being enhanced.

The successes already reported by its users in both industry and education are widespread. It has gained acceptance in over 9,000 companies, an increasing number of general, technical, and vocational schools, the armed forces, and several government agencies, as well as in several foreign countries.

At present programed texts offer the most economical route available to educators who want to move toward individualized instruction. Although the costs of producing programs locally may be prohibitive for most school systems, the purchase of commercially prepared materials is not. With the latter, the problem is more likely to be finding a program of high quality in the specific subject matter area desired.

A very skillful teacher can do whatever a program can do and at least as well as the program can do it - with one exception. The teacher can tutor only one student at a time. Programed instruction is one of a variety of instructional devices that should be put at the command of the teacher to help him do his job better. The teacher has been and will continue to be responsible for decisions about what is taught and how it shall be taught. Neither the teacher alone nor the program alone can do the effective job that the proper combination of both can do.

Following are a few predictions of what the future may hold for programed instruction.

1. History will someday record that programed instruction was the most effective development in giving access to learning since the invention of printing.

2. 1975 will find programming a major technique of instruction at all educational levels, in all parts of the world.

3. Although some schools and teachers will prepare their own programs, in most educational systems teachers will use commercially prepared programs.

4. Lastly, this writer agrees completely with the superintendent who said, "Although it is becoming evident that programed instruction can teach without a teacher's assistance, it seems to us that its greatest promise lies in its uses by an able, enthusiastic teacher as one of several tools."

See for yourself - try programed instruction in your school.

APPENDIX A

PROGRAMED TEXT MATERIALS AVAILABLE IN OCCUPATIONAL EDUCATION

SUBJECT MATTER AREAS AND THEIR PUBLISHERS

Since programed text publishers often produce and sell materials in several subject matter areas, this listing has been divided into two parts to avoid unnecessary duplication of sources. Part I lists the subject matter areas and the code numbers given to publishers who have materials available in that general area. These code numbers in turn correspond to a master list of 69 program publishers contained in Part II.

No claim is made that all available subject matter areas and their publishers are listed. Neither does listing here imply that the author has evaluated the program. Rather, listings were made on the basis of general announcements made available to the author by publishers.

PART I

Subject Areas and Sources

Adult Basic Education
Source(s): 24, 41

Agriculture - General
Source(s): 18, 19, 58, 67

Agricultural Mechanics
Source(s): 9, 18, 21, 32, 53, 67

Banking and Finance
Source(s): 1, 2, 17, 22, 39, 64

Blueprint Reading
Source(s): 41, 69

Bookkeeping and Accounting
Source(s): 1, 3, 19, 21, 38, 41, 49, 66

Business and Office Education - General
Source(s): 3, 8, 28, 56, 59, 63

Business English
Source(s): 8, 9, 17, 19, 41

Business Law
Source(s): 1, 17

Business-Machine Operation
Source(s): 13, 22, 37, 46

Business Management
Source(s): 8, 9, 17, 21, 22, 27, 38, 41, 50, 63, 68, 69

Business Mathematics
Source(s): 41, 59, 63

Business-Office Practice
Source(s): 8, 38

Business-Typing and Shorthand
Source(s): 3, 29, 38, 41

Construction
Source(s): 64, 69

Data Processing
Source(s): 5, 9, 17, 19, 31, 37, 41, 46, 48, 49, 68, 69

Drawing and Graphics
Source(s): 3, 18, 41

Economics
Source(s): 9, 10, 20, 21, 22, 41, 43

Electricity
Source(s): 1, 3, 17, 18, 23, 26, 29, 31, 38, 41, 49, 53, 68, 69

Electronics
Source(s): 3, 9, 15, 17, 20, 31, 38, 41, 49, 51, 65, 69

Health
Source(s): 10, 20, 21

Home Economics
Source(s): 21, 50

Industrial, Trade and Technical Education
Source(s): 3, 5, 6, 8, 9, 18, 23, 27, 38, 41, 53, 69

Insurance
Source(s): 1, 17, 52

Mathematics-Arithmetic
Source(s): 1, 14, 17, 18, 21, 28, 29, 30, 34, 39, 41, 42, 53, 56, 64

Mathematics-Modern
Source(s): 7, 10, 21, 29, 31, 33, 34, 39, 41, 43, 56, 68

Mathematics-Slide Rule
Source(s): 25, 30, 41

Mathematics-Other Areas
Sources(s): 1, 7, 10, 14, 17, 18, 20, 21, 25, 28, 29, 30, 33, 34, 41, 42, 48, 49, 51, 53, 57, 68

Measurement
Source(s): 18, 38, 44, 53, 69

Medical and Nursing
Source(s): 7, 9, 16, 20, 21, 29, 36, 40, 42, 45, 47, 55, 60, 61, 62, 63, 68

Parliamentary Procedure
Source(s): 17, 30, 42, 57

Personnel Practices and Supervision
Source(s): 1, 5, 8, 19, 35, 38, 41, 53

Safety
Source(s): 10, 18, 53

Science-Biology
Source(s): 3, 7, 12, 14, 17, 19, 20, 21, 28, 29, 41, 42, 48, 55, 61

Science-Chemistry
Source(s): 1, 3, 7, 11, 12, 14, 17, 19, 23, 28, 29, 30, 33, 45, 49, 55, 61, 68

Science-Other
Source(s): 3, 7, 10, 14, 21, 23, 25, 28, 29, 31, 33, 34, 39, 40, 41, 43, 48, 53, 56, 68

Selling and Retailing
Source(s): 8, 9, 22, 37, 39, 46, 50, 63

PART II

Directory of Programed Text Publishers -

With Subject Matter Relevant to Occupational Education

1. Addison-Wesley Publishing Company, Inc.
   Reading, Massachusetts 01867

2. The American Bankers Association
   90 Park Avenue, New York, New York 10016

3. American Book Company
   55 Fifth Avenue, New York, New York 10003
   300 Pike Street, Cincinnati, Ohio 45202

4. American Journal of Nursing, P. I. Reprints
   10 Columbus Circle, New York, New York 10019

5. American Management Association, Inc.
   135 West 50 Street, New York, New York 10020

6. American Society of Tool and Manufacturing Engineers
   20501 Ford Road, Dearborn, Michigan 48128

7. Appleton-Century-Crofts
440 Park Avenue South, New York, New York 10016

8. Argyle Publishing Corp.
200 Madison Avenue, New York, New York 10016

9. Basic Systems Inc.
880 Third Avenue, New York, New York 10022

10. Behavioral Research Laboratories
Ladera Professional Center, Box 577, Palo Alto, California

11. W. A. Benjamin
One Park Avenue, New York, New York 10016

12. Burgess Publishing Company
426 South Sixth Street, Minneapolis, Minnesota 55415

13. Burroughs Corporation
Detroit 32, Michigan

14. Central Scientific Company
1700 Irving Park Road, Chicago, Illinois 60613

15. Cleveland Institute of Electronics
1776 East 17th Street, Cleveland, Ohio 44114

16. Columbia University, Teachers College, Bureau of Publishers
525 West 120th Street, New York, New York

17. Doubleday & Company, Inc.
501 Franklin Avenue, Garden City, New York 10017

18. Du Pont Industrial Training Service
Room 7450, Nemours Building, Wilmington, Delaware 19898

19. Educational Methods, Inc.
20 East Huron Street, Chicago, Illinois 60611

20. Educational Systems Development
31270 Stephenson Highway, P. O. Box 457, Royal Oak, Michigan 48068

21. Encyclopaedia Brittanica Press
425 North Michigan Avenue, Chicago, Illinois 60611

22. Entelek Incorporated
42 Pleasant Street, Newburyport, Massachusetts 01950

23. Fearon Publishers, Inc.
2163 Park Boulevard, Palo Alto, California 94306

24. Follett Publishing Company
1010 West Washington Boulevard, Chicago, Illinois 60607

25. W. H. Freeman and Company
660 Market Street, San Francisco, California 94104

26. Friden Inc. Service Training Center
421 University Avenue, Rochester, New York 14607

27. General Programmed Teaching, Division of Commerce Clearing House, Inc.
424 University Avenue, P. O. Box 402, Palo Alto, California

28. Graflex Inc.
3750 Monroe Avenue, Rochester, New York 14603

29. Grolier Educational Corporation
575 Lexington Avenue, New York, New York 10022

30. Harper & Row, Publishers Incorporated
49 East 33rd Street, New York, New York 10016

31. Hayden Book Co., Inc.
116 West Fourteenth Street, New York, New York 10011

32. Hobart Welding School
Troy, Ohio

33. Holt, Rinehart & Winston, Inc.
383 Madison Avenue, New York, New York 10017

34. Honor Products Company
22 Moulton Street, Cambridge, Massachusetts 02138

35. Human Development Institute
1299 West Peachtree Street, N.E., Atlanta, Georgia 30309

36. Instructive Communications Unit
Training Branch, Communicable Disease Branch, Public Health Service, D.H.E.W., Atlanta, Georgia 30333

37. International Business Machines Corporation
6 Roosevelt Avenue, Endicott, New York 13760

38. International Educational Services, Inc., Division of International Textbook Company
Department 852A, Scranton, Pennsylvania 18515

39. Learning Incorporated
131 East Sixth Avenue, Scottsdale, Arizona 85215

40. J. B. Lippincott Company
East Washington Square, Philadelphia, Pennsylvania 19105

41. McGraw-Hill Book Company
330 West 42nd Street, New York, New York 10036

42. McMahon Electronic Engineering, Research and Development Laboratory
381 West Seventh Street, San Pedro, California 90731

43. The Macmillan Company
866 Third Avenue, New York, New York 10022

44. Model Publishing and School Supply Company
1604 Hodiamont Avenue, St. Louis 12, Missouri

45. C. V. Mosby Company
3207 Washington Boulevard, St. Louis, Missouri 63103

46. National Cash Register
Marketing Services, Dayton, Ohio 45409

47. National League for Nursing
10 Columbus Circle, New York, New York 10019

48. Pergamon Press Inc.
44-01 - 21st Street, Long Island City, New York 11101

49. Prentice-Hall Inc.
Englewood Cliffs, New Jersey 07632

50. Quaker Self-Study Program
345 Merchandise Mart, Chicago, Illinois 60654

51. RCA Institutes Inc.
350 West Fourth Street, New York, New York 10014

52. Research & Review Service of America, Inc.
123 West North Street, Indianapolis, Indiana 46209

53. Resources Development Corporation
Box 591, East Lansing, Michigan 48823

54. University of Rochester, Rochester Clearinghouse for Information on Self-Instruction in Medical Education
University of Rochester, Rochester, New York

55. W. B. Saunders Company
West Washington Square, Philadelphia, Pennsylvania 19105

56. Science Research Associates, Inc.
259 East Erie Street, Chicago, Illinois 60611

57. Scott, Foresman and Company
1900 East Lake Avenue, Glenview, Illinois 60025

58. Scott Visual Aids Service
110 Brantford Lane, Greenville, South Carolina 29605

59. South-Western Publishing Company
5101 Madison Road, Cincinnati, Ohio 45227

60. Springer Publishing Company, Inc.
200 Park Avenue, South, New York, New York 10014

61. Stipes Publishing Company
10 Chester Street, Champaign, Illinois

62. Superintendent of Documents
U. S. Government Printing Office, Washington, D. C. 20402

63. Teaching Systems Corporation
334 Boylston Street, Boston, Massachusetts 02116

64. TECO Instruction Inc.
3236 N. E. 12th Avenue, Ft. Lauderdale, Florida

65. Tektronix, Inc.
P. O. Box 500, Beaverton, Oregon 97005

66. Tutorinc
P. O. Box 432, La Porte, Colorado 80535

67. Vocational Agriculture Service
434 Mumford Hall, Urbana, Illinois 61801

68. John Wiley & Sons, Incorporated
605 Third Avenue, New York, New York 10016

69. Xerox Education Division
600 Madison Avenue, New York, New York 10022

APPENDIX B

SELECTED BIBLIOGRAPHY OF RECOMMENDED REFERENCES AND LIST OF SOURCES FOR FURTHER INFORMATION

Both the bibliography and the list of sources are highly selective. The lists contain valuable reference materials and resource information. Several types of references are included and many of these contain extensive listings of additional programed instruction materials.

Selected Bibliography

A. Books

1. Forbes, Jack E. A New Look at Programed Texts and Their Use. Encyclopaedia Britannica Press, 1965. 19 pp.

2. Glaser, Robert (ed.). Teaching Machines and Programed Learning II: Data and Directions. Department of Audiovisual Instruction, National Education Association, Washington, D. C., 1965. 831 pp.

3. Hendershot, Carl H. Programmed Learning: A Bibliography of Programs and Presentation Devices; 4th ed. Hendershot, 4114 Ridgewood Drive, Bay City, Michigan 48707, 1967.

4. Jacobs, Paul I., Milton H. Maier, and Lawrence M. Stolvrow. Guide to Evaluating Self-Instructional Programs. Holt, Rinehart and Winston, Inc., New York, 1965. 84 pp.

5. Lysaught, Jerome P., and Clarence Williams. Guide to Programed Instruction. Wiley, New York, 1963. 180 pp.

6. Mager, Robert F. Preparing Objectives for Programed Instruction. Fearon, San Francisco, California, 1962. 62 pp.

7. Programed Instruction in Large School Systems. Educational Research Service Circular, No. 7, National Education Association, Washington, D. C., 1966. 60 pp.

8. Rummler, Geary A. Programs: Development and Selection. Occasional Paper No. III, Center for Programmed Learning for Business, University of Michigan, Ann Arbor, 1965. 24 pp.

9. Ryan, William F. A Handbook of Programed Learning Information. The State Education Department, Albany, New York, 1964. 59 pp.

10. Salerno, Albert. An Evaluative Report on the Programed Learning Center. Mahoning Valley Vocational School, Experimental Project, Mimeo Report, Vienna, Ohio, 1965-66. 63 pp.

11. Schramm, Wilbur. The Research on Programed Instruction - An Annotated Bibliography. Office of Education, U. S. Department of Health, Education, and Welfare, Bulletin OE-34034, U. S. Government Printing Office, Washington, D. C., 1964. 114 pp.

12. Selection and Use of Programed Materials: A Handbook for Teachers. Division of Audiovisual Instructional Service, National Education Association, Washington, D.C., 1964. 71 pp.

B. Periodicals and Others

1. A. V. Communication Review. Department of Audiovisual Instruction, National Education Association, 1201 Sixteenth Street, N.W., Washington, D. C. 20036.

A quarterly which includes articles and reviews of publications of interest to those using programed instruction. Subscription $6.00 per year.

2. Audiovisual Instruction. Department of Audiovisual Instruction, National Education Association, 1201 Sixteenth Street, N.W., Washington, D. C. 20036.

Published ten times a year; subscription $6.00 per year. Articles provide information regarding educational media materials, techniques, and instructional developments.

3. Bulletin on Programmed Learning. Center for Programmed Learning for Business, The University of Michigan, Ann Arbor.

These bulletins are published regularly and are available upon request.

4. Bulletin - The Clearinghouse on Self-Instructional Materials for Health Care Facilities. The University of Rochester, School of Medicine and Dentistry.

These bulletins are published regularly and are available to those in the health field upon request.

5. NSPI Journal. National Society for Programmed Instruction, Trinity University, 715 Stadium Drive, San Antonio, Texas 78212.

This journal is published monthly; annual subscription $6.00.

6. Programed Instruction. The Center for Programed Instruction, Institute of Educational Technology, Columbia University. (No longer published.)

Reported research findings and other news about programed instruction.

7. Training in Business and Industry. Gellert Publishing Corporation, 33 West 60th Street, New York, New York 10023.

Contains up-to-date reports on what techniques business and industry are using, as well as advertisements by many producers of programed instruction and other educational media. Magazine is published monthly, is free to qualified personnel and available by subscription at $5.00 per year to others.

Selected List - Sources of Information

1. Center for Programmed Learning for Business
   The University of Michigan, 340 South State Street
   Ann Arbor, Michigan 48104

2. Department of Audiovisual Instruction, National Education Association
   1201 Sixteenth Street, N.W., Washington, D. C. 20036

3. Educational Media Branch, Office of Education
   U. S. Department of Health, Education and Welfare
   Washington, D. C. 20202

4. Institute of Educational Technology
   Teachers College
   Columbia University, New York, New York 10027

5. National Society for Programmed Instruction
   Trinity University
   715 Stadium Drive, San Antonio, Texas 78212

6. The Clearinghouse on Self-Instructional Materials for Health Care Facilities
   University of Rochester
   260 Crittenden Boulevard, Rochester, New York 14620

APPENDIX C

CRITERIA FOR ASSESSING PROGRAMED INSTRUCTIONAL MATERIALS

1962 Interim Report of the Joint Committee on Programed Instruction and Teaching Machines

American Educational Research Association

American Psychological Association

Department of Audiovisual Instruction, NEA

Prepared with the cooperation and support of the Educational Media Branch, U. S. Office of Education, under NDEA Title VII

THE members of the AERA-APA-DAVI Joint Committee include Harry F. Silberman, Evan R. Keislar, Robert Glaser, and Arthur A. Lumsdaine, Chairman (American Educational Research Association); Richard S. Crutchfield, James G. Holland, and Lawrence M. Stolurow (American Psychological Association); and Jack V. Edling, Edward B. Fry, Wesley C. Meierhenry, and Paul R. Wendt (Department of Audiovisual Instruction, National Education Association). **Helpful contributions were made to the preparation and review of the present statement by a cooperating committee of the American Society of Training Directors, whose members are Leonard C. Silvern (chairman), Robert L. Craig, Stanley L. Levine, Leonard Nadler, and Gerald H. Whitlock. Also contributing were several consultants and staff assistants, including Lloyd O. Brooks, Martin V. Covington, H. J. A. Goodman, Bert Y. Kersh, Susan M. Markle, Ernst Z. Rothkopf, and David G. Ryans. Further suggestions from program writers, publishers, or users are invited for the committee's use in the preparation of subsequent reports. This present article, as an interim report, can be interpreted as expressing a consensus of Joint Committee members rather than an official policy statement of AERA, APA, and DAVI.**

This statement by the AERA-APA-DAVI Joint Committee on Programed Instruction and Teaching Machines is concerned with educational techniques that are variously called "programed instruction," "auto-instructional" methods, and "programmed learning."

The present statement amplifies and extends the previous guidelines published in 1961 by the Joint Committee.[1] This report, like the previous one, is addressed primarily to the non-technical reader interested in the possible purchase of programs. It summarizes some basic aspects of the nature and current status of programed instruction, and also presents some suggestions and cautions concerning the assessment of programs.

A subsequent, more technical report will provide supplementary information and recommendations addressed to the technical specialist who is directly concerned with obtaining or interpreting quantitative data to indicate the effectiveness of programs in contributing to specified instructional goals.

Programed instruction. As used herein, programed instruction refers to the use of materials or procedures which incorporate an "auto-instructional" (or self-instructional) program. Such a program commonly attempts to provide conditions under which a student can learn something efficiently with little or no outside help. Current programs typically employ a pre-arranged sequence of material that is presented to the student one small unit at a time (e.g., a sentence or paragraph). Most programs require the student to respond actively at

1. This earlier statement by the Joint Committee was published in 1961 in the July-August issue of the AV Communication Review, the September issue of Audiovisual Instruction, and the November issue of the NEA Journal, as well as in a number of other educational periodicals.

least once for each unit (or "frame") of material - for example, by composing or selecting an answer to a question. Programs also commonly provide prompt confirmation or correction, as the case may be, for each response the student makes. In some cases, the program is presented by a mechanism or device called a "teaching machine"; in other cases it is presented by a specially designed form of book.[2]

Some Basic Considerations Concerning Programed Instruction

With or without the use of "teaching machines" for controlled presentation of programs, individual instruction by programed materials offers a very important potential resource for education. Attention to the following guidelines is suggested, however, in order that the potentialities of programed instruction may be effectively developed and utilized.

Experimentation and planning for school use. Programed instruction represents a relatively new and thus far largely experimental resource for education. Experimental tryout in schools, of both locally and commercially developed programs, is strongly encouraged. Wide-scale adoption of any particular program may well await the evaluation of one or more provisional tryouts of that program.

Curriculum planning. An important potential advantage of individual programed instruction is that abler learners can proceed at an accelerated rate through basic course material and thereby qualify sooner for advanced instruction. On the other hand, suitable programing may enable the slow learner to attain higher levels of proficiency than would otherwise be possible. Planning for adaptation of curricula to accommodate these possibilities needs to be undertaken as programed materials of demonstrated quality become available.

Perfecting programs through tryout and revision. Programed instruction affords outstanding opportunities for perfecting instructional sequences through successive revision based on detailed records of student response to preliminary forms of a program. The development of high-quality programs will generally entail considerable effort and expense. However, if costs can be pro-rated over a large number of students, a greater research and development effort can be invested in a program than might otherwise be considered feasible.

Tests of program effectiveness. Although the content which a program is designed to teach may be inferred from careful inspection of the program itself, external evidence based on student performance is needed to demonstrate how well the program actually teaches. However, the value of a method of instruction can not be tested in the abstract. For example, evaluation of a particular textbook is not an assessment of the usefulness of textbooks in general. A properly conducted experimental tryout or field test of a program may provide an assessment of that particular program, but does not afford proof or disproof of the value of a general "method" of programed instruction.

Experimentation conducted thus far supports the expectation that good programs, carefully developed, can significantly improve both the quality and economy of instruction. Whether any particular program will do so is subject to question until established by adequate tests of that program. Unfortunately, programs may be offered for sale that will fall short of the potential value of programed instruction - for example, because they have not been carefully developed through procedures that include sufficient tryout and revision to assure their effectiveness.

---

2. Detailed information about the development of teaching machines and programed-instruction concepts up to 1960 is contained in the source book, Teaching Machines and Programmed Learning, edited by Lumsdaine and Glaser and published by DAVI (724 p.; $7.50). A briefer treatise is Teaching by Machine, by L. M. Stolurow, published in 1961 by the U.S. Office of Education and obtainable from the U.S. Government Printing Office (173 p.; 65 cents). Reviews of several more recent books on programed instruction may be found in professional journals such as Contemporary Psychology, published by the APA, and the AV Communication Review, published by DAVI.

"TEACHING MACHINES"

Some programs require a machine for their presentation, while some are available only in book form. Other programs are available in two separate versions, one in book form and the other for use with a machine. In any case, it should be emphasized that so-called teaching machines, in themselves, do not teach. Rather, the teaching depends on the program of instructional materials that may be presented by a machine. The comparative merits of machine and non-machine presentation of printed programs for use in schools is as yet an unresolved issue. Any advantage for machine over book presentation can not be tested in the abstract but would depend on the characteristics of a particular machine. Some machines have demonstrable advantages for certain uses, including research; and suitable machines are required for programs that utilize audio materials.

Machine characteristics. The variety of types of teaching machines continues to proliferate, with little standardization. In evaluating any make or model of teaching machine, a continuing necessity is thus to assess the number and quality of programs available for use in it. For some machines the user who has sufficient time and skill can prepare his own programed materials; for other machines this may not be feasible. With some machines, a program can be reused indefinitely; for others a new copy of the programed material may be required for each student.

For many machines, mechanical dependability can not yet be taken for granted. As with any new mechanical device, potential purchasers of teaching machines are well advised to seek reliable information on how extensively the device has been used in schools, what maintenance problems have been encountered, and the extent to which parts and service are locally available at reasonable cost.

Availability of machines. Existing machines differ greatly in complexity and cost; prices for most of them range from a few dollars to several hundred dollars per machine. Any catalog of teaching machines is likely to be obsolete as soon as it is printed because the field is developing so rapidly. New machines appear, and some advertised models fail to get into production. Several dozen different machines are briefly described and illustrated in a 1962 publication by Finn and Perrin.[3] A number of these are commercially available at present. Others have been withdrawn from the market or were experimental models that have never gotten into production.

PROGRAMS

Availability of Programs

An increasing number of programs is becoming commercially available in a variety of subject-matter areas. Mere availability is no guarantee of quality, however. In addition, programs (as well as machines) are sometimes announced long before they are actually available; also, as noted above, some programs are in a format that can be presented only with a particular kind of machine.

A useful guide to available programs for school subjects is a 383-page government publication entitled Programs, '62.[4] This publication lists some 120 programs reported to be commercially available by September 1962. These programs span the curriculum from elementary to college levels and cover a variety of subject matter, including language arts, mathematics, music, physical and biological sciences, social studies, and business education. The report cited includes descriptive information and one or

3. Finn, J. D., and D. G. Perrin. Teaching Machines and Programed Learning 1962: A Survey of the Industry. Occasional Paper No. 3, NEA Technological Development Project. Washington, D. C.: U.S. Government Printing Office, 1962 (Publication No. OE-34019; 85 p., 55 cents). See subsequent footnote concerning information presented in this report.

4. The Center for Programed Instruction, Inc. Programs, '62: A Guide to Programed Instructional Materials. Washington, D.C.: U.S. Government Printing Office, 1962 (U.S. Office of Education, Publication No. OE-34015; 383 p., $1.50). See following footnote concerning information presented in this report.

more sample sequences from each program. Pertinent data given include the intended student population, the number of "frames" in each program, and its price, but no attempt is made to evaluate the programs.[5] It is anticipated that this compilation will be updated by similar guides for subsequent years.

Types of Programs

Programs are being produced in a variety of forms. Thus far they have tended to cluster around two or three main types; however, new variants or mixtures of types are also being introduced. The majority of current programs break the subject matter down into a large number of small steps or "frames," requiring the student to make one or more responses to each step. Such a program can be so designed that the student will respond to critical aspects of each frame or will get practice in performing the specific operation that each frame is meant to teach. Careful programing requires the programer to take great pains to insure that these steps embody a logical, well-sequenced progression of the subject matter. This applies especially to programs that are intended to serve as sole or independent sources of instruction rather than only as supplements to other material. Such programs often provide a number of examples to illustrate each principle, concept, or act that is to be learned.

Programs of the kind described above are designed to adapt to individual differences by allowing each learner to proceed at his own rate. In addition, some types of programs further adapt by providing for "branching" to alternate materials. For this purpose, frames may include questions designed to diagnose the learner's needs, with directions taking him to alternate material suited to these needs.

5. The reports on devices and programs identified in the two preceding footnotes are cited solely for the convenience of the reader, and statements concerning them are not to be construed as an endorsement by the Joint Committee or its parent organizations, either as to completeness or accuracy of the information presented, or of the quality of the devices and programs listed in these publications.

In most of the current "branching" programs, the program is so constructed that the choice of a particular answer to a diagnostic question determines which frame will be presented next. Incorrect answers may take the student to frames containing information designed to correct the error before allowing him to continue through the sequence, or to frames that provide supplemental information or practice.

There is little empirical basis at present to favor one general type of program over another. It may be anticipated that different types of programs will eventually prove to be especially useful for particular kinds of educational purposes, and that different styles of programing may be combined effectively in a single program. At the present time, however, the general pattern of one type or another of programing may be superficially followed without necessarily capitalizing fully on its potential advantages.

CRITERIA FOR ASSESSING PROGRAMS

"Internal" and "External" Sources Of Information About Programs

A useful distinction can be made between "internal" and "external" characteristics which might serve as possible criteria for program evaluation.

"Internal" characteristics refer to features that can be revealed through visual inspection of the program. These include both the content of the program and the way the program is constructed. Content might be described in terms of relative emphasis given to various topics as well as general organization of the material. Descriptive characteristics of program construction might include information about the length of frames, use of branching sequences, techniques of prompting, patterns of repetition and review, modes and frequency of response called for, procedures and scheduling of reinforcement, and the like.

"External" information about a program refers to features which cannot be observed merely by inspecting the program itself, such as the way it was developed and characteristics of its performance as a teaching instrument. External information of interest to a potential purchaser could include such

things as the source of program content, qualifications of authors, history of the program's development, tryout and revisions, and test data indicating gains in achievement produced by the use of the program. This information, as indicated more fully below, may be presented in a descriptive manual supplied by the program publisher.

Critical reviews of programs may furnish an additional basis for evaluation. Such reviews are beginning to appear in professional journals along with reviews of textbooks. (Some reviews include data on achievement attained by using the program as well as the reviewer's opinion about program content and style.)

Programs as Related to Textbooks and to Tests

The applicability of internal and external kinds of information as possible criteria for evaluating programs may in part be seen by comparing programs with textbooks and also with educational or psychological tests.

Programs as compared with textbooks. Both programs and textbooks may be inspected to determine what topics are covered and the relative amount of attention given to each. Such inspection would also indicate whether the subject matter is factually correct, whether it is current, etc. However, despite their similarities, programs differ from textbooks in several important respects that may affect their evaluation. A program's requirement for frequent student response generates a special source of data useful for revising the program in detail. The tendency to empirically guided development of programs is coupled with an orientation toward testing the specific effects produced by a program, and toward more sharply focused objectives defined in terms of specified behavioral outcomes. In addition, the program is intended to generate a more predictable pattern of student behavior than does the study of a textbook, which generally has a less specialized purpose in aiming to serve as a reference source as well as a sequence of instruction.

Programs compared with psychological and educational tests. Although programs aim primarily to instruct students rather than to test them, programs and tests share some important attributes. Since both generate student-response data as an inherent feature, both tend to be developed in terms of empirical procedures. The difficulty of each item in a program, as in a test, can be investigated by presenting the program to appropriate samples of students and recording their responses. Both the program and the test have limited ranges of usefulness that can be described to the potential user in terms of empirical evidence; and in both cases it is possible to specify an external criterion to indicate the extent to which some intended outcome is achieved, as evidenced by the kinds of behavior that have been developed or differentiated.

Uses of Internal and External Information For Assessing Programs

Inspecting the subject-matter content of programs. At the present time, the principal recommended use of internal data obtained from inspection of the programed materials is for determining whether program content is appropriate to the educator's objectives. As with other educational materials, program titles often are not definitive. Programs labeled with the name of a particular subject matter can vary widely in terms of content and associated instructional objectives. The prospective purchaser of a program should, therefore, inspect the content of the program at least as carefully as he would that of a textbook. Preferably he should go through the entire program to determine what aspects of the subject are treated or omitted, and the extent to which particular sub-topics are developed.

Limitations of program inspection. A risk in relying on inspection for evaluating a program is that one's perception of its value may be inappropriately influenced by his reaction to particular structural features of the program. For example, certain frames or items may seem too difficult or too easy. However, the difficulty and appropriateness of items in a program, like those in a test, generally cannot be judged accurately by inspection alone. External data are needed - data from an actual tryout of the program on students who are representative of the population of intended users.

The need for test data to assess a program's effectiveness. Empirical evidence on what is learned from the program can also be a better basis than mere inspection for answering such questions as whether program sequences have too much or too little repetition, review, prompting, overlap of steps, etc. At present, the scientific evidence is not considered sufficient to permit accurate prediction in these respects or to justify recommendation that adherence to specific rules of program construction be used as a basis for program evaluation. External evidence is recommended as the main basis for the evaluation of program effectiveness - in particular, test data obtained from using a program under specified conditions which provide dependable measures of gains produced in student achievement and of the time students require to achieve these gains.[6]

Uses and assessment of programs. Programs may have a variety of uses. For example, they may be intended to provide the main source from which students are expected to learn facts, principles or skills - or they may be intended only to review or introduce other instruction. In most schools, programs will probably be used in conjunction with other media of instruction. However, no matter what eventual use is contemplated for a program, it will generally help a prospective user to know what the program itself actually contributes to the students' knowledge or proficiency - in addition to what is contributed by other elements in the instructional situation.

The kinds of effects that can be revealed through empirical tryout are limited by the content of the achievement tests or other measures used to assess these effects. Inspection of the program by the prospective purchaser, supplemented by independent protimes suggest additional uses for which a program might be suitable, or kinds of program effects which are not indicated by field-test data because they were not contemplated in the programer's original purpose.

Inspection of achievement-test content. Aside from the data obtained in texting a program's use under laboratory or field conditions, inspection of the program itself as a basis for appraisal can be supplemented if the author or publisher has spelled out the program's purpose by describing and exhibiting in full the achievement-test items which purport to exemplify what the program is intended to teach. These criterion-test items, as well as responses called for by the program and test, can be examined to see what the learner is required to be able to do, and whether this reflects the kind of competence which the educator wishes to achieve. Such an analysis of test content as a basis for determining a program's objectives may be particularly helpful for programs which are intended to serve as a primary source of instruction rather than merely as an adjunct to other instructional material.

REPORTING DESCRIPTIVE INFORMATION ABOUT PROGRAMS

Manuals for Providing External Data

"Manuals" for tests and programs. Because some of the characteristics needed to appraise educational and psychological tests are revealed only through data obtained by using them, it has become accepted practice to furnish information about test characteristics in a manual supplied by the test producer. It appears both desirable and feasible to provide a similar manual for programs as a vehicle for presenting relevant external information about properties which are not apparent on inspection.

Questions that might be answered about a program. Information presented in a manual can help program producers or distributors to answer questions which the prospective purchaser may wish to ask as a basis for selection. Several areas of such questions concerning external information about a program may be identified. These questions might deal with (1) the program's

6. This emphasis on external criteria for assessing program effectiveness is consistent with the position earlier advocated in Lumsdaine and Glaser's 1960 "Concluding Remarks" (op. cit., p. 566), and in Rothkopf's (1961 conference report, "Criteria for the Acceptance of Self-Instructional Programs," in Improving the Efficiency and Quality of Learning, A. E. Traxler, editor. Washington, D. C.: American Council on Education, 1962, p. 30-38.

purpose and intended use, (2) the source of program content, (3) the way the program was developed, including tryout and revision, and (4) the conduct and results of testing to determine empirically the effectiveness, or "performance characteristics," of the published program. The last of these kinds of information will generally be considered the most important; however, it also involves the kind of data which may be hardest to evaluate as to adequacy without specialized technical advice.

Purpose and Scope of a Program Manual

The kind of manual here suggested could apply to all types of programed materials. However, some of the details appropriate for some programs probably would not apply to others. For example, less test data would probably be needed in the case of very short programs.

It is expected that the main user of such a manual would be the school district or other large-scale purchaser interested in buying programs in considerable quantity. To evaluate fully some of the data that could appropriately be included would generally require advice from a technical consultant who has professional training and competence in testing and measurement techniques as well as in statistics and experimental design. However, the manual also could well supply general interpretive information to help the non-technical purchaser determine the program's relevance to his educational purposes. Such information could precede and refer to, when appropriate, the presentation of the technical detail needed for the specialist to appraise a program's effectiveness.

Program "labels." In addition, a digest of the information in the manual might be presented as a brief preface or "label" attached to individual copies of the program. Such a label could, at a minimum, indicate the purpose and intended use of the program, who was primarily responsible for its content and preparation, and the source of publications in which further data on its development and effectiveness might be found. This information should include the age- or grade-level(s) of the learners for whom the program is designed, and the prerequisite skills and abilities these learners are assumed to have. The publisher could then characterize and briefly illustrate the kind of competences the program has been demonstrated to produce when used in the manner suggested.

Further Information on Source and Development of Program Content

A more detailed manual which could be supplied by the program publisher to prospective users on request might elaborate this minimum information in relation to further questions, such as the following, which concern the source and development of program content.

Sources of content. What textual or curriculum sources were used in the selection and development of the content? How current were these sources? Who were the programer(s) and the collaborating curriculum specialists or subject-matter consultants (if any), that prepared, edited and reviewed the program materials? What are their academic and experience qualifications with respect to competence in the subject matter and techniques of programing? To what kind of review was the program material subjected during its development?

Development, tryout, and revision. As previously noted, records of learners' responses to preliminary versions of a program can provide a basis for its progressive revision and improvement prior to publication. Accordingly, the prospective purchaser might wish information about the extent to which such tryout and revision has been conducted, the kind and amount of student-response data obtained, and the way in which the data were used in revising the program. The manual might also indicate the criteria used to determine when the program was ready for final release and printing prior to the effectiveness testing on which the performance characteristics of the published program are based. As supplementary information, the producer might also wish to indicate the assumptions made and principles used in constructing the program.

Information About the Demonstrated Effectiveness of a Program

It is to be hoped that the manual for a

program, at least for major programs of considerable scope, will furnish evidence on the program's effectiveness based on measurement of student performance on pre- and post-program criterion tests. These tests should be exhibited either in the manual or in an available supplement, so as to exemplify what the producers expect the student to learn as a result of program use.

Program producers are strongly encouraged to support any claims for the effectiveness of the programs in terms of gains in student performance produced by the final, published version of the program, as revealed by appropriate criterion tests. A clear distinction should be made between this effectiveness-test data for the final program and any test data obtained in earlier tryouts of preliminary versions used as a basis for revision. (Changes made in the program after the later effectiveness-test data are obtained could throw doubt on the validity of these data for a demonstration of the program's effectiveness.)

The manual should present whatever further information would seem helpful in evaluating the reported effects of the program or the adequacy of the evidence on which they are based. It should in all cases present evidence to document for the technical reader that the gains in achievement reported can rightly be attributed to the effect of the program's use rather than to extraneous causes. In addition, it should describe the physical and social conditions of the program's use and effectiveness-testing procedures in sufficient detail so that their essential features could be reproduced by another investigator if desired. This information would include details of supervision and incentives used, other instruction given, size of student groups, and physical arrangement of rooms during program use and testing. Any material discrepancies between recommended conditions of use and those that were employed in obtaining the effectiveness-test data should be noted. Students' prior experience with programs and teaching machines, if any, should be noted in view of spuriously large temporary gains that can sometimes result as a novelty effect when a new device or procedure is first introduced.

The manual should indicate how many of the students started and completed the program, the average length of time they required to finish it, the average level of performance on the specified pre- and post-program tests of achievement, and the range or variability with respect to these measures. Relevant further temporal data would include the amount of time learners of different ability spent on various portions of the program, how this time was distributed (especially for long programs), and the time lapse between the completion of the program and the criterion test.

Effectiveness tests could of course be conducted so as to include post-program measures other than the test that specifies the programer's objectives. The program's effect on secondary objectives not originally aimed at could thus also be revealed. However, whether or not such tests are conducted by the producer or by others (e.g., by a prospective user or by an independent research agency), it is to the programer's interest to specify what he intended as the program's principal objectives. Finding a program to be ineffective or of only limited effectiveness for contributing to a secondary or unintended objective might be helpful to the user in making a decision about the use of the program for that purpose, but cannot properly be held as a criticism of the programer's effort.

It is anticipated that a school district contemplating the use of a program will be interested in its effect on performances other than those tested by the program producer. Particularly in this case, it is recommended that, when possible, potential users assess a program by their own field tests, guided by suitable technical consultation, before deciding on adoption of a program for wide-scale use. Performance characteristics of a program could specify its effectiveness in affecting behavior of students describable as changes in knowledge, understanding, skill or other outcomes, including beliefs, interests, and motivations.

Learner characteristics. Specification of prior knowledge and ability of learners can serve both to identify the pre-program base line from which gains may be measured, and also to indicate what prerequisites are needed in order to learn effectively from the program. Learner characteristics may be

specified as an aspect of the program's purpose and intended use. The corresponding characteristics for the samples of students used in preliminary tryouts or, particularly, in the effectiveness-testing of the program, should be separately specified so as to indicate the degree to which these learners were typical or atypical of the learners for whom the program is intended. The producer should also indicate the limits (particularly the lower limits) of the population for whom the program is intended, and of the samples used in testing its effectiveness.

Technical information concerning the conduct of effectiveness-testing. Valid assessment of what is taught by the use of a program generally involves special technical problems. Evaluation should, whenever possible, utilize the assistance of technical specialists having recognized competence in educational measurement and experimental design. The analogy of programs with standardized educational and psychological tests also suggests a precedent for preparation of technical recommendations by members of relevant professional organizations. These recommendations can serve both to help insure the technical soundness of effectiveness-testing procedures, and to promote comparability and interpretability of data by fostering consistently high standards of practice in reporting the results of tests. The further interim report to be published at a later date by this Committee will discuss in more detail some of the technical problems of assessing what the use of a program, in and of itself, contributes to definable instructional goals.

RECOMMENDATIONS FOR REPORTING

THE EFFECTIVENESS OF PROGRAMED INSTRUCTION MATERIALS

(Adapted from October, 1965 revision)

I. INTRODUCTION

This report has been prepared by the Joint Committee on Programmed Instruction and Teaching Machines of the American Educational Research Association, the American Psychological Association, and Department of Audio-Visual Instruction (National Education Association).[1] The work of this committee has been supported by the Educational Media Branch, Office of Education, U. S. Department of Health, Education, & Welfare, under Title VII of the National Defense Education Act. The parent associations have charged the committee with providing useful guidance to publishers and purchasers of programed instruction materials.[2] The present recommendations are intended to help in improving the effectiveness of program selection and utilization. This report supplements the 1962-63 committee report, to which the reader is referred for background.[3]

Purpose and Content

The report provides assistance primarily to potential users concerned with the selection and effective use of instructional programs. It also provides guidance to those who publish programs or report data on program effectiveness. The present report deals with recommendations concerning information on the effects that a given program can be shown to produce, regardless of how these effects may relate to the user's purposes. Supplement I to this report contains suggestions for information to be included in a program manual for teachers and other users who require information about program characteristics. Supplement II contains recommendations intended to serve as a guide for those who are preparing technical documentation in support of statements about the outcomes that a program can produce.

II. RECOMMENDATIONS ON REPORTED EFFECTIVENESS OF PROGRAMS

The basic premise of this report is that instructional effectiveness must be judged for each program, according to its demonstrated merits. Evidence for the effectiveness of a program should be based on a detailed study which has been fully documented in a technical report. As emphasized in its 1962-63 report, the committee takes the position that effectiveness of each program must be determined by measurement of the instructional outcomes which the program's use can be shown to bring about. At the present state of the art, users generally cannot assess the effectiveness of a particular program reliably by mere inspection of the program or by reference to statements about its developmental history.

A. General Recommendations

Recommendation 1:

Evidence for the effectiveness of a program should be based on a carefully conducted study which shows what the program's use accomplished under specified conditions. Such a study must employ suitable before and after measurements, with control procedures to insure that effects attributed to the program can be clearly distinguished from the effects of other instruction.

Recommendation 2:

The results of the evaluation study should be carefully documented in a technical report prepared in keeping with accepted standards for scientific reporting. (Specific recommendations for the preparation of such documents are presented in Supplement II to this report.)

Recommendation 3:

All claims or statements about the effectiveness of a program should be supported by specific reference to the evidence contained in the technical report.

B. More Specific Recommendations

It is assumed that data on the effectiveness of programs will be obtained and reported by: (1) program producers, (2) using agencies, including school systems, and (3) projects conducted by universities and other research agencies. Accordingly, some further specific recommendations and suggestions, given below, are addressed to prospective users, program publishers, reviewers, and research agencies or institutions which conduct or report assessment studies.

The uses of program-assessment data differ depending upon the needs and technical experience of the user. For most teachers and school administrators, reports are needed which report the effectiveness of an instructional program in fairly straightforward terms that are quickly comprehensible without examining detailed technical data. On the other hand, a detailed account of all experimental procedures and instruments used in assessment is needed for the technical evaluator, who must critically analyze the study to see if the summarized results and interpretations are warranted.

1. Recommendations for the prospective purchaser or user:

a. Prospective users should evaluate each program on its own merits according to its demonstrated effectiveness in producing specified outcomes.

b. In determining the suitability of any program for a particular purpose, the prospective user should first formulate his own objectives in as much detail as possible and then evaluate the program in relation to these objectives in the light of three things:

(1) The apparent appropriateness of the program content for his purposes, as based on inspection of the program itself and of the producer's statement of the program's objectives. These objectives may be inferred from tests supplied by the producer for measuring the intended outcomes of the program.

(2) Consideration of factors affecting practicality, or feasibility of use, such as the unit cost of the program, initial and maintenance cost of a machine (if required), and factors affecting supervision, scheduling, and other aspects of administration.

(3) Evidence on the demonstrable effectiveness of the program in terms of outcomes relevant to the user's objectives. (These may include motivational, or attitudinal, effects as well as subject matter competences.)

c. The prospective user is advised to ignore all claims for the effectiveness of a program which are not backed up by appropriate data that have been subjected to competent evaluation. Advice on the soundness of claims for program effectiveness should preferably be obtained from a technical advisor or reviewer who has competence in the fields of educational psychology, measurement, and experimental design and who has reviewed available reports on the effects of the program in the light of technical recommendations identified in Section 5 herein.

d. In addition to consulting reviews published in professional journals, users should seek all available data on demonstrated performance characteristics of the program, not only from information supplied by the producer but also from reports prepared independently: for example, reports prepared by school systems, research projects, or other agencies that have conducted program assessment studies of the particular program.

2. Recommendations for program publishers:

The following recommendations, plus recommendations 4a-4e following, are offered to assist the program producer in providing necessary information which will help users make intelligent choices among available programs.

a. The publisher should state in detail the minimum objectives of his program, preferably in terms of specific behaviors or competences which its use is intended to achieve for specified kinds of learners.

b. Publishers should refrain from promoting a program in terms of general statements about the value of programed instruction as a general "method," or on the basis of statements about its effectiveness not supported by detailed data, as recommended herein.

c. Publishers should provide a program manual, preferably one that can be updated or supplemented as new data on the program become available. (See suggestions for the content of such a manual provided in Supplement I to this report.)

d. Preliminary limited editions of programs, prior to validation by definitive evaluative studies meeting the conditions of technical adequacy indicated herein should be issued to facilitate collection of evaluation data. These should always be clearly identified to the purchaser as experimental or preliminary editions.

e. Publishers should use a suitably descriptive title for the program, one which appropriately delimits the scope of the subject matter and skills taught. Relatively longer titles and use of subtitles and detailed tables of contents are recommended.

3. Recommendations for reviewers:

To assist users in evaluating programs, those who prepare reviews might, in addition to expressing their opinions about the suitability of the program content and objectives, be guided by the following suggestions and by recommendations 4a-4d.

a. Take into account all available assessment data.

b. Evaluate and interpret such data in the context of technical considerations such as those set forth in following sections and amplified in Supplement II to this report.

c. Make available (for example, in a supplementary report or by deposit with the American Documentation Institute) any relevant details of his analysis of assessment data which require more space than is appropriate for a published review in professional journals.

d. Utilize a procedure and format of reporting which provides a thorough analysis required of the program. (When appropriate, reviewers might consider employing a set of topical headings related to program appro-

priateness, such as producer's statement of program objectives, appropriateness of objectives to current curricular concepts, suitability of objectives and program to the designated student population, etc. Where data from a formal study to assess program effects are available, the reviewer should evaluate the data in the light of the criterion measures used, adequacy of description of test populations, description of conditions of experimental and intended program use, degree of correspondence between conditions of testing and of intended application, etc.)

4. Recommendations addressed jointly to program producers, reviewers, and technical advisors:

The following recommendations recognize that data on the effects of programs may vary from impressions based on observations of one or two subjects, as they work through a program, to a full-scale, formal study in which the program's specific effects on learning, retention, motivation, and application of knowledges and skills are determined for representative populations of students under varying conditions of use. In the formal study, these data may be analyzed to show differing effects for subgroups of varying aptitude and background.

Informal tryouts and subjective impressions can be useful when intended to serve as guidance to the programer in revising early versions of a program. The teacher also receives some value from informal tryout when a rough overall "screening test" is desired to help decide whether or not a program seems to "work" (in the sense of being generally suitable for its intended purpose).[4]

The recommendations that follow are concerned primarily with the reporting of formal and rigorous assessment studies which are required for determining in some detail the performance characteristics of a program - that is, the specific outcomes which a program can be shown to be reliably capable of producing.

a. Reported data on effectiveness should refer to the effects produced by the program itself, unless other instructional sources are clearly identified, and their contribution is assessable. (Although most schools use programs in conjunction with other media of instruction, it will generally help a prospective user to know what the program alone actually contributes to the student's knowledge or proficiency, apart from what is contributed by other elements in the instructional situation.)

b. Program producers should cite the available evidence from their own studies of the program to document any claims they make about the effectiveness of the program. Publishers as well as reviewers should also cite any pertinent evidence available from all documented studies of the program that are known to them.

c. Publishers and reviewers should differentiate clearly and explicitly between (1) mere opinions, of experts or others, about the probable effectiveness of the program, and (2) documented evidence on the outcomes its use has been actually shown to produce.

d. While brief summary statements may often appear in advertising copy or brochures, or on the cover or label of a program, or in a program manual, or a review, such summary statements should always reference the technical report on which they are based, so that the correspondence between interpretive statements and underlying data is made explicit.

e. Summaries of information concerning a program's demonstrated effectiveness should be made widely available in published sources of general distribution. It is suggested that program producers report such data in a program manual and that using agencies (such as school systems and research projects) also publish the results they obtain, on any commercially available program, in appropriate professional journals. These agencies should provide copies of their reports to the publisher of the program as soon as they are completed and ready for publication.

f. To insure continued availability of technical reports and of data not published in full in standard books or journals, at least one complete copy of the technical report and of all basic data tabulations should be furnished to a suitable depository such as the American Documentation Institute or University Microfilms, and this fact should be noted in the teacher's manual.

5. Recommendations Concerning Technical Reporting:

These recommendations, in addition to Recommendations 4a-4f above, are addressed to those concerned with obtaining, reporting, or evaluating the adequacy of information from empirical studies of the effects of programs. The recommendations summarized here are amplified in Supplement II to this report.[5]

a. In accordance with basic criteria of scientific reporting, the entire evaluation procedure should be reproducible. This applies to the derivation, administration, and description of criterion measures as well as to the selection of the experimental population and all aspects of experimental design and procedure. The technical report should describe the procedures used and the results obtained in such a way that a technically-qualified person (1) can assess the validity of the statements concerning what outcomes the program's use will achieve and (2) could replicate the study in substantially identical fashion.

b. To satisfy this basic requirement, the technical report should give full details on all relevant aspects of the evaluation study, including criterion measures, characteristics of subjects, conditions of program use and data collection, experimental design, and data obtained. Some of the more specific aspects of such topics dealt with in Supplement II are:

(1) Procedures employed in measuring of retention, transfer, and attitude, and other dependent measures such as time to reach a criterion.
(2) Characteristics of students as indicated by measures of prior knowledge, competence, intelligence, aptitude, etc.
(3) Procedures and scheduling of program use, related instruction, conditions of administration.
(4) Procedures used in sampling and assignment of subjects, use of control and comparison groups, controls for so-called Hawthorne and related spurious (in the sense of extraneous - Ed. note.) effects, and account taken of "pall" effects.
(5) Processing, tabulations, analysis, and summarization of data, tests of significance and reporting fiducial limits, etc.

FOOTNOTES

1. Committee members are: Harry F. Silberman, Evan R. Keislar, Robert Glaser, and Arthur A. Lumsdaine, Chairman (AERA); Richard S. Crutchfield, James G. Holland, and Lawrence M. Stolurow (APA); and Jack V. Edling, Edward B. Fry, Wesley C. Meierhenry, and Paul R. Wendt (DAVI). Ernst Z. Rothkopf served as consultant, and Brett B. Hamilton as staff assistant, in the preparation of this report. Helpful contributions were made to the preparation of the present statement by members of a cooperating committee of the American Society for Training and Development (formerly American Society of Training Directors) under the chairmanship of Leonard C. Silvern. The present report represents a consensus of the Joint Committee members rather than official policy of AERA, APA, or DAVI. Further suggestions from program writers, publishers, or users are invited.

2. A useful guide to available programs for school subjects is the government publication entitled Programs '63, prepared by the Center for Programed Instruction (U.S. Office of Education. Publication No. OE-34015-63; 814 pp., $2.50). This publication lists some 350 programs reported to be commercially available by the end of 1963, and includes descriptive information, price, and one or more sample sequences from each program, though with no attempt to evaluate the programs. Another useful compilation of programs, which includes more programs but gives less detail on each program is Programed Learning: A Bibliography of Programs and Presentation Devices, edited by Carl H. Hendershot, and published by Delta College, University Center, Michigan. This listing has been updated quarterly (L/C Cat. No. 64-11824; $3.50).

3. The 1962-63 report was entitled "Criteria for Assessing Programmed Instructional Materials," and was published in Audiovisual Instruction, February, 1963, pp.

84-89; it has also been reprinted in several other educational journals and books.

4. Suggestions concerning such classroom tryouts by the teacher are offered in the booklet Selection and Use of Programed Materials: A Handbook for Teachers, published by the Division of Audiovisual Instruction Services of the National Education Association, Washington, D. C. (1964: Library of Congress catalogue number 64-23523); 50¢ per copy.

5. For further background on rationale, techniques, and problems in assessing the effectiveness of instructional programs the reader may wish to consult the chapter by A. A. Lumsdaine entitled "Assessng the Effectiveness of Instructional Programs" in the book Teaching Machines ani Programed Learning II; Data and Directions (Ed. by R. Glaser, Washington, D.C.; National Education Association, 1965).

APPENDIX D

BIBLIOGRAPHY

BOOKS

A Guide for Wiley Authors in the Preparation of Auto-Instructional Programs; 3rd ed. John Wiley & Sons, Inc., New York, 1967. 14 pp.

Currie, Dorothy A. Selected Reading on Programed Learning: A Bibliography. Bureau of Secondary Curriculum Development, The State Education Department, Albany, New York, 1966. 66 pp.

Fanning, Robert J. Programed Instruction Project--Annual Report, 1965-66. Board of Education, New York, 1966. Various paging.

Forbes, Jack E. A New Look at Programed Texts and Their Use. Encyclopaedia Britannica Press, 1965. 19 pp.

Glaser, Robert (ed.). Teaching Machines and Programed Learning II: Data and Directions. Department of Audiovisual Instruction, National Education Association, Washington, D.C., 1965. 831 pp.

Hendershot, Carl H. Programmed Learning: A Bibliography of Programs and Presentation Devices; 4th ed. Hendershot, 4114 Ridgewood Drive, Bay City, Michigan 48707, 1967.

Hughes, J. L. (ed.). Programed Learning: A Critical Evaluation. Educational Methods, Chicago, 1964. 238 pp.

_____. Programed Instruction for Schools and Industry. Research Associates, Chicago, 1962. 299 pp.

Jacobs, Paul I., Milton H. Maier, and Lawrence M. Stolvrow. Guide to Evaluating Self-Instructional Programs. Holt, Rinehart and Winston, Inc., New York, 1966. 84 pp.

Keiserman, Stanley W., and Peter T. Harkness. Education for Occupations--Grass Roots Thoughts and Beliefs in New York State--A Summary of the Multicounty Area Studies. Bureau of Occupational Education Research, The State Education Department, Albany, 1967. 82 pp.

Lunsdaine, A. A., and Robert Glaser (ed.). Teaching Machines and Programmed Learning: A Source Book. 1960. 724 pp.

Lysaught, Jerome P., and Clarence Williams. Guide to Programed Instruction. Wiley, New York, 1963. 180 pp.

Magen, Robert F. Preparing Objectives for Programed Instruction. Fearon, San Francisco, California, 1962. 62 pp.

Margvlies, Stuart, and Lewis D. Eigen (eds.). Applied Programed Instruction. John Wiley & Sons, New York, 1962. 387 pp.

Mechner, Francis, Donald A. Cook, and Stuart Margvlies. Introduction to Programed Instruction. Basic Systems, Inc., New York, 1962.

Norton, Robert E. Using Programed Instruction With and Without Self-Instructional Practice to Teach Psychomotor Skills. Ph.D. Thesis, Cornell University, Ithaca, 1967. 104 pp.

Oflesh, Gabriel D., and Wesley C. Meierhenry (eds.). Trends in Programmed Instruction. National Education Association, Washington, D. C., 1964. 289 pp.

Programed Instruction in Large School Systems. Educational Research Service Circular, No. 7, National Education Association, Washington, D. C., 1966. 60 pp.

Rosen, Ned A., and Emil A. Mesics. Programmed Instruction. New York State School of Industrial and Labor Relations, Reprint Series No. 141, Cornell University, Ithaca, 1963. 10 pp.

Rummler, Geary A. Programs: Development and Selection. Occasional Paper No. III, Center for Programmed Learning for Business, University of Michigan, Ann Arbor, 1965. 24 pp.

Ryan, William F. A Handbook of Programed Learning Information. The State Education Department, Albany, 1964. 59 pp.

Salerno, Albert. An Evaluative Report on the Programed Learning Center. Mahoning Valley Vocational School, Experimental Project, Mimeo Report, Vienna, Ohio, 1965-66. 63 pp.

Scanlon, James A. The Relative Effectiveness of Supplementing Programed Instruction With Blocked Versus Spaced Review. Ph.D. Thesis, Cornell University, Ithaca, 1967.

Schramm, Wilbur, et al. Four Case Studies of Programed Instruction. The Fund for the Advancement of Education, New York, 1964. 120 pp.

_____. Programed Instruction - Today and Tomorrow. The Fund for the Advancement of Education, 477 Madison Avenue, New York, 1962. 74 pp.

_____. The Research on Programed Instruction - An Annotated Bibliography. Office of Education, U. S. Department of Health, Education and Welfare, Bulletin OE-34034, U. S. Government Printing Office, Washington, D. C., 1964. 114 pp.

Selected NSPI Talks, 1965. Center for Programmed Learning for Business Staff, University of Michigan, Ann Arbor, 1965. 78 pp.

Selection and Use of Programed Materials: A Handbook for Teachers. Division of Audio-visual Instructional Service, National Education Association, Washington, D. C., 1964. 71 pp.

Stolvrow, Lawrence M. Teaching by Machine. U. S. Department of Health, Education and Welfare, Office of Education, Cooperative Research Monograph No. 6, OE-34010, U. S. Government Printing Office, Washington, D. C., 1961. 173 pp.

PERIODICALS AND OTHER SOURCES

Bulletin on Programmed Learning. Center for Programmed Learning for Business, The University of Michigan, Ann Arbor. Several issues.

Bulletin - The Clearinghouse on Self-Instructional Materials for Health Care Facilities. The University of Rochester School of Medicine and Dentistry. Several issues.

Finigan, Frederick. "Programed Sales Training," Department Store Economist, April 1965.

Dupont Magazines including Agricultural Newsletter, Dupont Magazine and others. E. I. Dupont de Nemours Co., Wilmington, Delaware. Several issues.

Hartley, J. "Research Report," New Education, Vol. 2, No. 1, 1966.

Hilgard, Ernest R. "What Support from the Psychology of Learning?," NEA Journal, Nov. 1961, pp. 20-21.

Komoski, P. Kenneth. "Programed Instructional Materials," Programed Instruction, Vol. 5, Nos. 3 and 5, 1966.

_____. "Programed Instruction and Modern Educational Objectives," an address presented at the 30th Annual Education Conference, October, 1965, mimeo. 7 pp.

Langewieshie, Wolfgang. "Now You Can Double Your Learning Power," Readers Digest, Vol. 91, No. 500, April 1967, pp. 112-116.

Lysaught, Jerome P. "Research on Programmer Training: What Has Been Done; What Needs Doing," NSPI Journal, Vol. VI, No. 5, 1967, pp. 6-9.

Mathetics Supplement reprinted from "Programed Instruction" issued by the Center for Programed Instruction, Inc., Vol. 3, Nos. 3 and 4, December 1963 and January 1964, 15 pp.

Morris, Barry (ed.). "The Function of Media in the Public Schools," A position paper, National Education Association, Washington, D. C., 1962. 8 pp.

NSPI Journal (National Society for Programed Instruction). Trinity University, San Antonio, Texas. Several issues.

Programed Instruction. The Center for Programed Instruction, Institute of Educational Technology, Columbia University. (No longer published.) Several issues.

"Programmed Instruction: New Path to New Skills," Moonbeams, The Proctor and Gamble Company, July 1966.

Training in Business and Industry. Gellert Publishing Corp., New York. Several issues.

Training and Research. Newsletter of Resources Development Corporation, East Lansing, Michigan. Several issues.

"What is a Teaching Machine," Promotional Brochure, Grolier Educational Corporation, New York, 1967.